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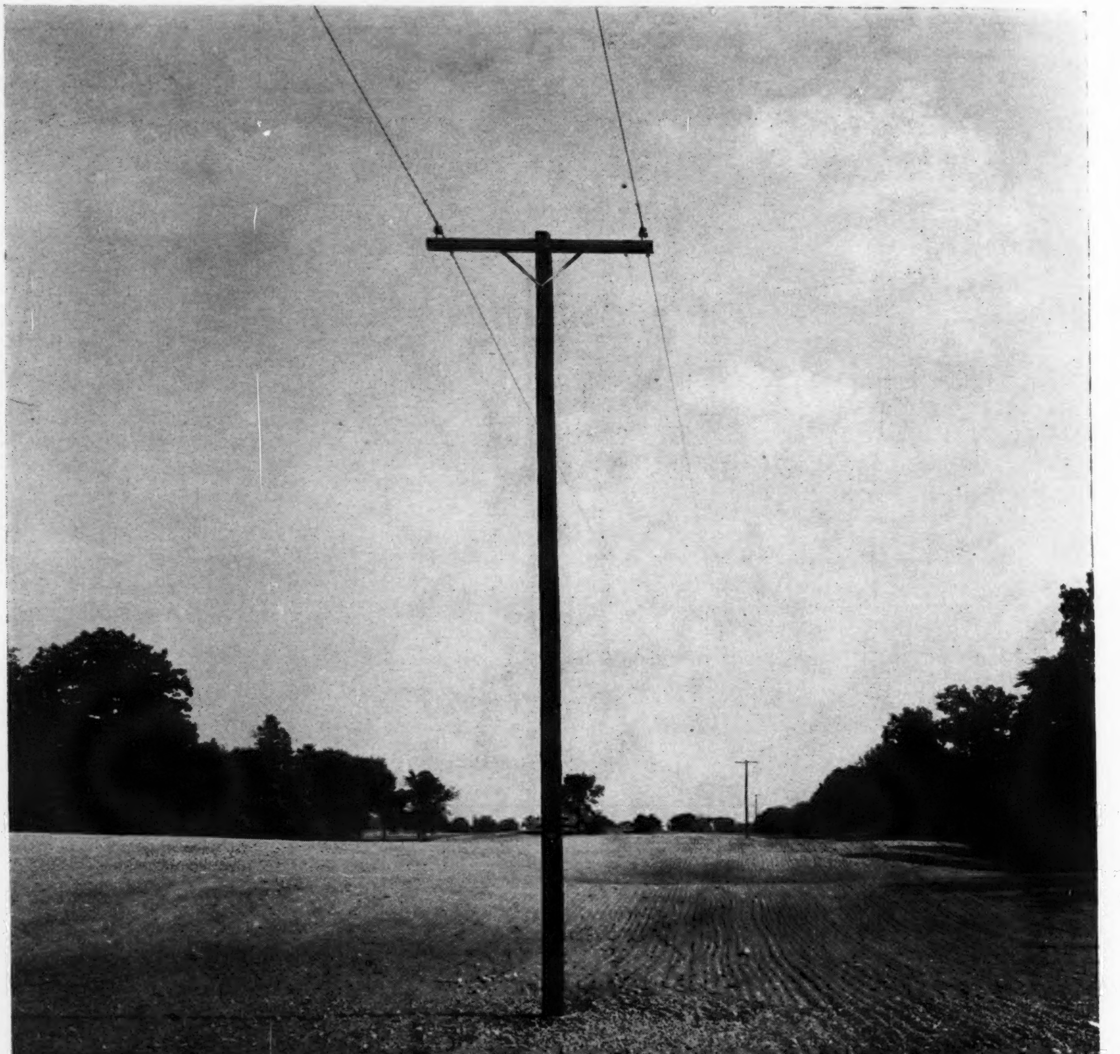

Monument to an Endless Job

HIGH LINES give wings to low-cost water and steam power. They reach out to serve the very soil in which their poles are anchored. They are the framework of a new agriculture. They dangle within reach of the adjoining farmers a new tool—how versatile and potentially useful no one yet knows. An indication of the potential usefulness of this new farm tool is the sum of alternating current effects and combinations thereof, multiplied by the range of present and potential utilization equipment, by the sum of present and potential agricultural industries, and by the aggregate of functions and operations involved in those industries.

The substantial start which has already been made in extending central station current as a source of farm light, power, and heat is only an introduction to the endless task of meticulously investigating each technical possibility, improving and developing new equipment, testing it in farm operation, studying its use economy, informing farmers of its availability, place, and use methods, and finally inducing them to give it a fair trial. Rural electrification needs not only to be brought up to full utilization of its present possibilities, but to be kept abreast of other developments in electrical and agricultural science and farming practice, and to point the way to new developments. Much of this is work for agricultural engineers.

AGRICULTURAL ENGINEERING

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U.S.D.A. Reorganization

ENOUGH progress has now been made in the current reorganization of the U. S. Department of Agriculture to justify comment on how the new setup will affect agricultural engineers and agricultural engineering work in the Department.

The plan calls for a new bureau, not yet named, to take over and correlate the chemistry program of the present Bureau of Chemistry and Soils and much of the engineering research of the present Bureau of Agricultural Engineering. The drainage and irrigation phases of agricultural engineering, however, are to be transferred to the Soil Conservation Service, and the soils work of the Bureau of Chemistry and Soils and some of the irrigation and drainage engineering work relating to plants is to be transferred to the Bureau of Plant Industry.

There are to be three assistant chiefs of the new bureau, who will have direct charge of distinct phases of its activity, one for engineering, one for chemistry, and one for administration of the four new regional laboratories which will work on new uses for farm products. One of the reasons for this consolidation appears to be the better integration of research in chemistry and engineering relating to new and expanded uses for farm products. Proposed plans for the new bureau also contemplate expansion of the Department's work in agricultural engineering. The primary concern of the new bureau is to use both engineering and chemistry in a coordinated way to produce results of value to farmers.

Inasmuch as agricultural engineering cuts across every branch of agricultural science, perhaps the greatest service of agricultural engineers to agriculture, and the fullest development of agricultural engineering, may result from this tendency toward horizontal expansion of agricultural engineering work in the Department. The Soil Conservation Service, for example, already employs a staff of many agricultural engineers. Agricultural engineers are to be found also in the Office of Experiment Stations, the Agricultural Adjustment Administration, and the Farm Security Administration.

The Civil Service Commission will presumably continue to hold examinations for its several grades of agricultural engineers, to rate them as such, and to certify them for employment as agricultural engineers anywhere in the civil service that they might be needed.

From the viewpoints of several agricultural engineers and others closest to the reorganization plans, the present outlook provides increased opportunity for agricultural engineering service to agriculture, and is definitely favorable. Agricultural engineers, we are confident, will measure up to that opportunity.

Nut Cracking Technique

AS AN example of the advantage of a new approach to an old problem, we rarely run across anything better than the California story, elsewhere in this issue, on cracking English walnuts by internal combustion.

California English walnut growers presented their cracking and meat picking cost problem to the agricultural engineering division of the California agricultural experiment station, and received their answer in the form of an experimental machine that materially cuts these costs. That was important from the standpoint of inspiring public confidence in agricultural engineers.

What was more important, from the standpoint of research performance, was the fruitfulness of a fresh viewpoint and of an engineering analysis of the essentials of the problem. We may well imagine that Roy Bainer had a good long siesta, with his feet on his desk, contemplating a solitary English walnut with a view to something more than his individual gastronomic satisfaction. As a physical unit, the walnut had two sides, an inside as well as an outside. The shell could be, and habitually was, cracked by some application of differential pressures. Commercially, it was being cracked toward the meat, from the outside, by various mechanical elaborations of hammers and rollers, with a high percentage of damaged meats and of small shell particles mixed in with the meats.

If the shell could be cracked by pressure from the inside, it might fall away from the meat, and fewer meats might be damaged. Space between the shell and the meat suggested the possibility of injecting an explosive. A notch could quickly be sawed through the shell automatically, while the nut was moving along a production line. An explosive gas might be injected through the notch from a jet, also on a production line basis, and ignited by a flame or spark. Acetylene is an economical, commercially available, easily controlled explosive gas with no harmful products of combustion. An experimental machine proved the principle.

It may be that there are other agricultural "nuts," figuratively speaking, which could be cracked from the inside by a combination of fresh viewpoint and an engineering analysis of the basic physical, chemical, commercial, and other considerations involved.

Research, Patents, and Public Service

RESEARCH often leads to invention, and invention to patents. Publicly supported research institutions have a long standing problem of administering inventions and patents of their personnel for the greatest good of their supporting public. That some progress is being made in arriving at sound policies is indicated in a paper which Leonard J. Fletcher presented in November before the annual convention of the Association of Land-Grant Colleges and Universities.

Mr. Fletcher quoted various authorities, including a public institution, to the effect that public patents do not usually achieve the desired end. Simple devices which an individual can make for his own use, or as a small craft enterprise, will get into public use by way of the public patent. High-grade manufacturing, however, involves extensive investment in design and development for quantity production, in tooling up for production, in materials, labor, advertising, and sales effort, before any return is realized. The public patent offers no protection to this investment against other manufacturers capitalizing on it to duplicate the product at a lower cost and to capture the market with a lower selling price. The result has been that many useful articles dedicated to public use by public patents have been lost to the public through lack of a manufacturer. In this day of need of new industries, that is tragic.

The bright spot in the picture is the growing concept

that the public to be served by the patent system and publicly supported research is larger than the group of potential manufacturers of inventions resulting from such research. The practical impossibility of giving any and all manufacturers equal opportunity for manufacturing profit on any one invention is being realized. The concern of the institution is that the article shall be made as readily available to the public as possible, that science and useful arts shall be encouraged by appropriate reward to the inventor and to the institution, and that manufacturers, as a section of its public, shall have an equal opportunity to cooperate with the institution in the development of new products or in the solution of other technical problems. It must be free to license any one or a limited number of manufacturers to produce an invention according to its view of how the public interest will best be served.

Research Viewpoints

"RESEARCH is misunderstood by a great many people, but in its simplest form it may be defined as an organized and diligent application of existing knowledge to unearth new facts.

"Time was, during the early stages of industry, when satisfactory advances could be made by utilizing existing stores of knowledge, but it has been aptly said, 'existing stores of knowledge are now pretty well picked over.' Today there arises the need for new knowledge specifically applicable to the advancing needs of industry and the public. One reason which prompts industry to make investments in research is, therefore, economic — the old 'first law' of nature: self-preservation.

"While the primary reason for industry carrying on a research program is based on the profit motive, there is another and more fundamental argument in its favor, and that is the social. And if we considered the social viewpoint only, it is very probable that we would automatically fulfill the requirements of the more immediate incentive.

"Surely scientific research offers the greatest promise in providing and maintaining a high percentage of employment, to the end that the greatest possible number of people may have all the necessities and many of the comforts of life."—Charles B. Nolte, president, Crane Company, in "Crane Research Laboratories" 1938.

* * *

"It is an axiom in science and engineering that what can be done in a laboratory may be done on a large scale—what cannot be done there cannot be done on a large scale." —Frank B. Jewett, in "The Engineer and Current Trends in Economic Thought," Journal of the Western Society of Engineers, June 1938.

* * *

"The third certainty is that organized research has become the dominant competitive weapon for the individual establishment. And more than research, the development of a new idea from its genesis until the time when it meets the acclaim from the consumer is a fresh art, the knowledge of which is enabling many companies to establish entirely new competitive frontiers. It is safe to say that within the next decade the company which cannot introduce into its processing the new product, the new design, the new formula with as great facility as it introduces raw material into its process will be definitely obsolete from the point of competitive armament. The measure of this need in any particular establishment is simple. The rate at which older markets wane establishes the rate at which newer markets must be developed."—Erwin H. Schell, in "Current Certainties in a Time of Low Visibility," American Gas Journal, March 1938.

* * *

"Intensive research is a conservative investment. In competent hands it may be confidently expected to pay dividends. Not every project will be brought to a successful conclusion, but some should yield results of sufficient immediate value to pay for the failures and to leave a material balance on the credit side."—William D. Coolidge, quoted in "Industrial Bulletin" November 1938.

* * *

The scientist, in his laboratory, subjects his theories or his opinions to repeated tests of such a character that he gets facts which speak for themselves and cannot be refuted.

The remarkable success of this method of thought, as applied to scientific developments, suggests the possible application of the same method to other fields of thought. —Dr. Ernest B. Benger, general assistant chemical director, E. I. du Pont de Nemours and Co., September 1938.

* * *

"Dr. Lyman J. Briggs, director of the National Bureau of Standards, took as his definition of research, the classification as presented by Julian Huxley in his book, 'Science and Social Needs.' He divided research into four categories: (1) background research with no practical objective consciously in view, such as atomic physics; (2) basic research which must be fundamental in character but has some distant practical objective, such as the study of fluorescence with the distant possibility of producing cold light; (3) ad-hoc research, with an immediate objective like research on discharge tubes for lighting purposes; and (4) development or engineering research, which is the work needed to translate laboratory findings into full-scale commercial practice."—From A.E.C. Bulletin, November 1938.

* * *

Huxley's classification might well be interpreted in terms of agricultural engineering. Few, if any, agricultural engineers will directly participate in background research. That is pure science, a field for physicists, chemists, and biologists. Engineers usually have some practical objective in mind. Background research has, in the past, furnished and developed much of the scientific knowledge later applied in research with practical objectives, and probably will continue to do so.

Basic research in agricultural engineering might include, for example, study of forces, materials, and structural organization of soils, with the distant practical objective of improving and lowering the cost of farm crop production. An example of ad-hoc research, with an immediate objective in a portion of the same field, would be a study of gumbo soils, in search of principles which might make possible the design of a plow with improved scouring qualities. Development research would apply the principles found in a design for factory production.

Huxley's classification seems an appropriate aid to research agricultural engineers in defining and classifying research problems and objectives, and in determining a line of attack on any specific problem, in consideration of existing background knowledge.

High-Leakage Transformers as Alternating Current Fence Controllers

By H. W. Riley and S. Krasik

ELECTRIC energy supplied to stock fences must be controlled by some device to limit to a safe amount the current that can flow to a person or animal touching the fence. Of the several types of controllers now on the market, in this paper only the high-leakage, constant-current, alternating-current transformer will be considered.

High-leakage transformers receive central station, alternating-current power in the primary winding and deliver from the secondary an electrical voltage of the same frequency and of essentially the same wave form as that received from the power line. The current limiting action of transformers of this type is dependent upon the shunt magnetic path provided between the two windings which permits flux to thread one winding without threading the other.

A transformer consists essentially of a primary and a secondary winding connected by some path for magnetic flux. In order to analyze the performance of iron-cored transformers by standard circuit theory it is necessary to set up an equivalent circuit. There are many such equivalent circuits which vary in the degree in which they approximate the actual characteristics of the transformer in question. In Fig. 2 is shown the simplest equivalent circuit that can be employed to approximate the high-leakage transformer. It should be understood that this approximation is one that is very rough but adequate for this discussion. The capacitance C is not part of the equivalent circuit but represents a load. In the equivalent circuit of Fig. 2, E is the rms (root mean square) voltage in the transformer secondary when no current is being drawn from it; L is the inductance of the secondary plus that of the primary transferred to the secondary (in henrys); and R_T is the resistance of the secondary winding plus that of the primary in secondary terms, plus all resistances between the source of power and the transformer, all in secondary terms, plus the equivalent resistance due to the energy losses in the core of the transformer. For the preliminary discussion a load of capacitance alone is indicated by C (in farads).

Presented before the Rural Electric Division at the fall meeting of the American Society of Agricultural Engineers, at Chicago, Ill., December 1, 1938.

Authors: Respectively, professor and head of the agricultural engineering department (Charter A.S.A.E.) and graduate assistant, physics department, Cornell University.

Current I from the voltage source E will flow through the different elements in the circuit shown, each of which will offer to the flow a characteristic opposition—resistance, reactance, or impedance—which will call for an individual voltage drop to overcome it. The mathematical expression for the reactance in ohms of both the inductance L in henrys and the capacitance C in farads involves the term "omega" which is $\omega = 2\pi f$, where f is the frequency of alternations per second of the source E. Inductive reactance $= X_L = \omega L$, and the voltage drop $E_L = IX_L$. The reactance of capacitance $= X_C = 1/\omega C$, and the voltage drop $E_C = IX_C$. For ohmic resistance, impedance $= R$ and the voltage drop $E_R = IR$. An important fact is that in electrical phase relationship E_L leads the current I by 90 deg, E_R is in phase with I, while E_C lags the current by 90 deg and is thus in direct phase opposition to E_L, and both are 90 deg away from E_R.

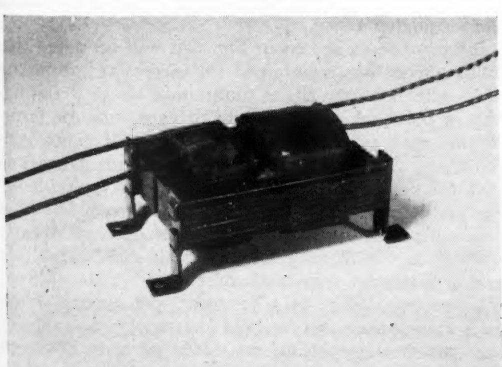
The presentation of these facts and symbols prepares the way to consider in detail the subject of resonance in the circuit in Fig. 2. Current will flow from E through L and R_T to C and back again to E. The current flowing will be

$$I = \frac{E}{\sqrt{R_T^2 + (\omega L - 1/\omega C)^2}} \qquad [1]$$

If now the values in ohms of the term ωL and $1/\omega C$ are exactly equal, which shall here be considered as resonance, this equation becomes

$$I = E/R_T \qquad [2]$$

Now R_T, which may be relatively small, becomes the only factor tending to limit the current flow. The current at resonance is therefore higher than it would be if the circuit were not in resonance, and as a result the voltage drop across L and C becomes greater since these drops are directly proportional to the current. For this simple circuit, since



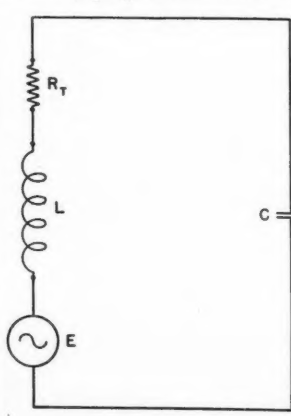
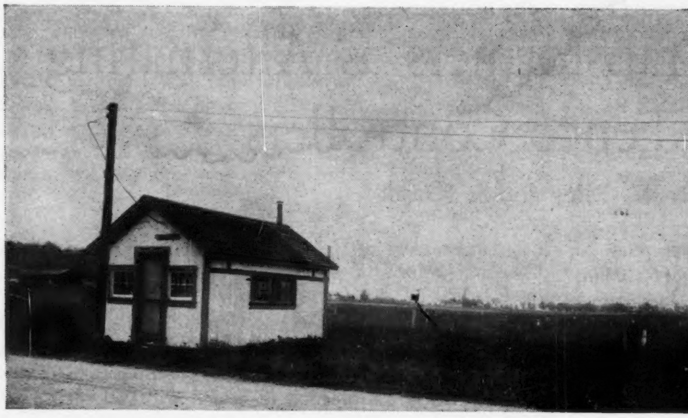


FIG. 1 (LEFT) A HIGH-LEAKAGE TRANSFORMER. FIG. 2 (RIGHT) APPROXIMATE EQUIVALENT CIRCUIT OF HIGH-LEAKAGE TRANSFORMER AND CAPACITANCE LOAD



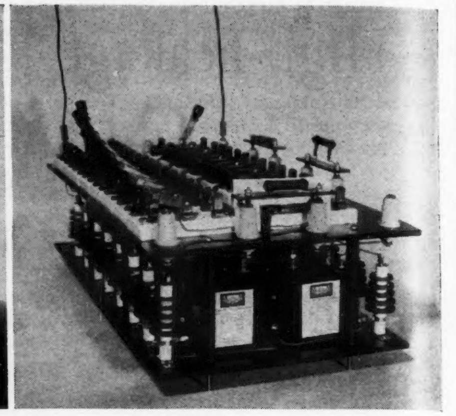


FIG. 3 (LEFT) TEST FENCES AT CORNELL UNIVERSITY. FIG. 4 (RIGHT) ARTIFICIAL FENCE AS BUILT USING 7000-VOLT CORNELL-DUBILIER TYPE C-86 TRANSMITTING CONDENSERS

$E_L = IX_L$ and since at resonance, by equation 2, $I = E/R_T$, at resonance

$$E_L = E\ X_L/R_T \qquad [3]$$

when X_L is larger than R_T, E_L will be greater than E. If the transformer is loaded with resistance, as R in Fig. 8, as well as with C, E will be kept from attaining the extreme values possible from equation 3.

The above discussion indicates in an elementary way how high voltages and high currents are possible at resonance. It may be concluded that a transformer that may operate at resonance must be insulated for the voltages that may exist, and the winding must be of sufficiently heavy wire to carry the resonance current without undue heating. Furthermore, a high voltage drop implies a large flux in the core. Therefore, the core must be sufficiently large in cross section to keep the flux density down to some reasonable value. Unless the transformer is designed with these precautions in mind, it will overheat seriously if operated continuously at a resonance condition. Controllers in which the primary voltage is interrupted and in which the off-period is many times the on-period, may in general be operated at resonance without observing these precautions, although the insulation must be adequate. In the continuous type controller operated at or near resonance a slight resistive load of 1,000,000 to 2,000,000 ohms built into the controller and shunting the output will assist materially in reducing the maximum voltages and currents occurring at resonance, thus reducing the size and cost of the transformer required but not affecting appreciably its performance as an electric fence controller. Usually, however, the leakage resistance of most fences will serve this purpose.

In the spring of 1937 there were set up at Cornell University for testing purposes five one-mile lengths of actual test fence as shown in Fig. 3. The electrical characteristics of these fences were determined, and then an electrical circuit for laboratory testing, called an artificial fence, was designed and set up which simulated the properties of an actual fence of single-strand barbed wire 36 in from the ground. Actual fence capacitance was 0.015 microfarads per mile. The first condenser in the artificial fence is of 0.005 mf capacity and all the others of 0.01 mf capacity, so the test steps are first 1 mi and thereafter 2/3 mi of fence for each switch change.

For use in the artificial fence the resistance R, which represents the effect of an animal or person touching the fence and the effect of fence leakage, as in Fig. 8, is provided by from one to three radio-type resistors in series as shown in Figs. 4 and 5. These are mounted on strips of 1/8-in bakelite between banana plugs spaced to fit the pairs of socket type feed-through stand-off insulators shown. The flow of current is determined by Ohm's Law from the measured resistance of one resistor and the voltage drop across it measured either by a high-resistance voltmeter or by an oscilloscope. The oscilloscope was used on interrupter type controllers and the voltmeter on continuous type controllers and interrupted type controllers in which the interrupter was blocked out. Most of the data taken were by the latter method. By means of the S.P.D.T. switch the resistance can be connected to either the near or the far end of the fence. For each value of R used, readings of primary voltage and voltage drop across the measured resistance were taken for each of a series of capacitances corresponding to fences from zero to 10 mi of fence. Resistance values ranged from 100 ohms to 1 megohm. Careful consideration of all possible errors in this general procedure indicates an estimated overall error in data thus obtained of less than 7 per cent.

The results of an interrupter blocked test of a characteristic high-leakage transformer connected to the artificial fence are shown in Fig. 6 plotted to logarithmic scales in order that a wide range of values of current output and load resistance can be covered in a reasonable space. Current through R in milliamperes rms is increasing vertically upward, and load resistance R (Fig. 8) increases toward the right. The lowest load resistance at the left represents conditions approximating a short circuit to ground while the resistance values toward the right approximate conditions of poorer conductivity and at the extreme right the load resistance is about the order of the leakage resistance of a well-insulated fence.

In the test results shown in Fig. 6 it will be noted that maximum current was maintained for increasing grounding resistance with but very slight diminution up to a falling-off point, a point which was found to vary with the transformer and with the capacitance or length of fence connected. When this critical amount of load resistance was exceeded, the delivered current began to decrease decidedly. With further increase of load resistance, the current fell off at an increasing rate until it reached a rate of decrease directly proportional to the increase in load resistance. This rate of decrease thereafter remained constant.

If, by proper design or adjustment, the current delivered by a transformer can be held practically constant for either a 100-ohm grounding resistance or a 50,000-ohm grounding resistance, then such a properly designed or ad-

justed transformer should work equally well in controlling cattle regardless of the wetness or the dryness of the ground, if we assume 50,000 ohms to be the maximum grounding resistance of an animal. It can be shown both by experiment as per Fig. 6 and by mathematical analysis that, if the length of fence connected is such as to produce resonance in the circuit, the high current rate is sustained to a higher grounding resistance than if the circuit is not in resonance. In other words, the full current will be maintained for drier conditions if the circuit is in resonance than would be the case if it were not in resonance. At just how large a grounding resistance the falling-off point will occur for resonance will depend on the design of the transformer.

In testing a transformer, if it is connected to only the grounding resistance with no fence capacitance in the circuit, the falling-off point of the current will occur at some certain grounding resistance as shown by curve 1 in Fig. 6. If now the transformer is connected to a moderate length of fence, its performance will be improved; the falling-off will be delayed; it will deliver full current for drier conditions, that is, a larger grounding resistance. By adding more fence there will be still better performance (curve 2), and this betterment will continue until enough fence has been connected so that its capacitance is just right to produce resonance (curve 3). If now the length of connected fence is increased, the falling-off point will become progressively poorer with further addition of fence length. When twice as much fence is connected as that needed to produce resonance, the falling-off point will be about the same as that for no fence connected (curve 1). As more fence is added the falling-off point will occur at smaller and smaller resistances to ground.

The theory and discussion so far have implied that the controller is operating continuously under a steady state condition. We mean by a steady state condition that each cycle or alternation of the voltage or current is identical with every other one in size and shape. Now when any change is made in an electrical circuit carrying a current, or if a current is set up in a circuit which had no current in it previously, the steady state is not immediately attained but instead there is an initial state called a transient state. The currents and voltages existing during this state, which may be as short or shorter than a millionth of a second or as long or longer than several seconds, depending upon the circuit, are called transient voltages and currents, or simply transients. Now in a high-leakage type transformer controller in which the primary is interrupted, the secondary will not immediately attain the steady state value when the interrupter closes, but will undergo a transient condition. Similarly when the circuit is broken, the current will not

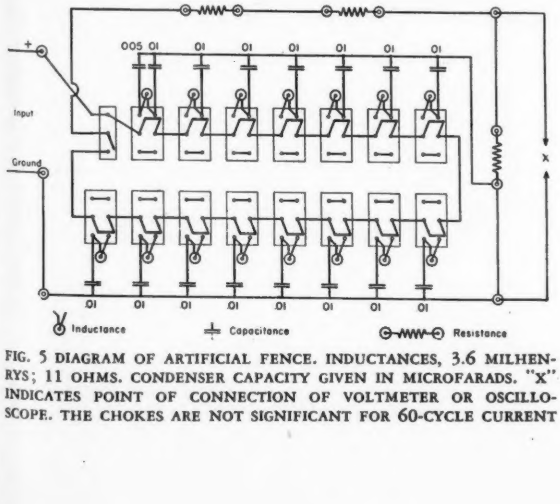


FIG. 5 DIAGRAM OF ARTIFICIAL FENCE. INDUCTANCES, 3.6 MILHENRYS; 11 OHMS. CONDENSER CAPACITY GIVEN IN MICROFARADS. "X" INDICATES POINT OF CONNECTION OF VOLTMETER OR OSCILLOSCOPE. THE CHOKES ARE NOT SIGNIFICANT FOR 60-CYCLE CURRENT

immediately fall to zero. The diagrams of electric fence discharges given in Fig. 7 show two transient 60-cycle voltages, that in A causing the initial first half-cycle to be decreased, and that in B to be increased. It can be seen in these figures that the steady state is established within about one-half alternation. Tests carried on under many conditions indicate that the steady state is well established within the first cycle for circuits in which we are here interested. Thus, in an interrupter type high-leakage transformer controller, if the on-period of the interrupter is as much as 3 cycles, which was the case in the controller having the shortest on-period of those tested, the interrupter blocked tests will give a good measure of the performance of the controller during its on-period.

If the fence is grounded through an animal or person touching it, there will also be a transient if the controller is of the continuous type, or if it is of the interrupted type and the fence is touched during the on-period. The effect of this transient has not been studied in this investigation, but under most conditions it would not seem to be of as great significance as the main steady state shock since it probably must overcome the high initial skin resistance.

We shall now consider a simple theory of the operation of a high leakage transformer energizing a fence of capacitance C considering also a shunt load R to ground. We are considering here only steady state conditions. The diagrams and symbols in Fig. 8 are the same as in Fig. 2, except that R has been introduced to represent the combined effect of the fence leakage and animal contact that may be grounding the fence.

If we call I the current through R, this will be the actual current to the animal or person touching the fence, except for the leakage current, which on a well-insulated fence will be a small fraction of I for operating conditions. We find when this circuit is solved mathematically that

$$I = \frac{E}{\sqrt{R^2\left[(1-\omega^2LC)^2 + \omega^2R_T^2C^2\right] + 2R\,R_T + R_T^2 + \omega^2L^2}} \qquad [4]$$

To simplify this we can at once drop out R_T^2 because R_T, in most transformers, is so much less than ωL that R_T^2 can be neglected in comparison with ω^2L^2. Also if R is as small as 100,000 ohms or less, then $2RR_T$ can also be neglected as being insignificant in comparison with the other terms. Equation 4 for our conditions thus becomes

$$I = \frac{E}{\sqrt{R^2\left[(1-\omega^2LC)^2 + \omega^2R_T^2C^2\right] + \omega^2L^2}} \qquad [5]$$

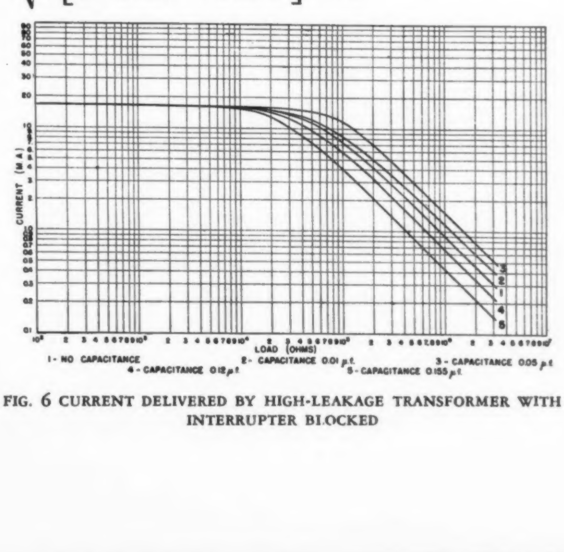


FIG. 6 CURRENT DELIVERED BY HIGH-LEAKAGE TRANSFORMER WITH INTERRUPTER BLOCKED

Case I. When there is connected to the transformer no fence, or a fence so short that capacitance C in equation 5 may be neglected, the two terms involving C become negligible and we have

$$(1-\omega^2 LC)^2 = 1 \text{ and } \omega^2 R_T^2 C^2 = 0$$

and equation 5 becomes

$$I = \frac{E}{\sqrt{R^2 + \omega^2 L^2}} \qquad [6]$$

For no fence connected and wet weather conditions, such that R is much smaller than ωL, we have approximately

$$I = E/\omega L \qquad [7]$$

It is this equation that indicates the conditions that hold the curve in Fig. 6 as a nearly horizontal straight line up to the falling-off point. If R_T is small compared to ωL, it can be shown that this expression also determines the maximum steady state current that the transformer can deliver with or without resonance and is therefore an important test measurement.

As field conditions become drier, with very little fence connected, R becomes of the same order of magnitude as ωL, and equation 6 applies for the portion of the curve in Fig. 6 where the current begins to fall from the nearly constant delivery line. Beyond this point, for conditions where R is very large, ωL becomes relatively insignificant and equation 6 becomes approximately

$$I = E/R \qquad [8]$$

This is the portion of the curves in Fig. 6 which falls at the constant slope of 45 deg. It does not interest us since it is out of the useful range of the controller.

Case II. This involves resonance resulting from the capacitance of the connected fence.

For resonance we mean $\omega^2 LC = 1$, and as a result, in equation 4, the term $(1-\omega^2 LC)^2 = 0$. Also for most controllers at resonance the term $2RR_T$ in equation 4 amounts to more than does the term $R^2\omega^2 R_T^2 C^2$, although this may not be so in controllers, the inductance of which is so small that a very large capacitance is required to cause resonance. Usually, however, (C being of average value) we may write for resonance

$$I = \frac{E}{\sqrt{2RR_T + \omega^2 L^2}} \qquad [9]$$

This is similar to the equation 6 for no capacitance in Case I, except that we have the term $2RR_T$ instead of R^2. This means that, since R_T is relatively small, $\omega^2 L^2$ is predominant for larger values of R than in the previous case (equation 6) and that the flat portion of the curve extends to higher values of load resistance at resonance than it does without resonance.

Case III. When the capacitance is twice the value required for resonance in equation 5 the term $(1-\omega^2 LC)^2 = 1$, the term $\omega^2 R_T^2 C^2$ may be neglected, and we find for this case that equation 6 applies as for Case I. Thus for no capacitance and for twice the resonance capacitance the performance curves are practically identical.

Case IV. When the capacitance is three times the resonance value in equation 5, the term $(1-\omega^2 LC)^2 = 4$, the term $\omega^2 R_T^2 C^2$ may be again neglected, and we obtain from equation 5

$$I = \frac{E}{\sqrt{4R^2 + \omega^2 L^2}} \qquad [10]$$

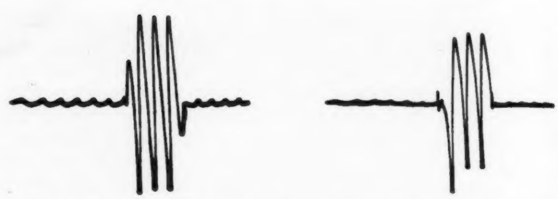


FIG. 7 (A, LEFT; B, RIGHT) OSCILLOGRAMS OF ELECTRIC FENCE DISCHARGES

Now $4R^2$ becomes of the same order as $\omega^2 L^2$, when R is only one-half as large as that in equation 6, and as a result the break in the curve occurs sooner than for Case I, and the performance curve falls below that for no capacitance.

For capacitances four times the resonance value, the coefficient of R^2 is 9, and for longer fences the performance becomes progressively poorer. Thus theory confirms the experimental findings as shown in Fig. 6.

It follows from this discussion that the optimum performance of a high-leakage transformer fence controller is realized at resonance, as far as uniformity of control in dry and wet weather is concerned. Most users of electric fences have some arbitrary length of fence which they wish to control, so the next question is how to attain a condition of resonance or near resonance for various lengths of fence, since the length of fence causing resonance is fixed for any given transformer. One method of doing this is to connect an additional inductance or choke coil across the output of the controller. The action of this inductance is to nullify the effect of a portion of the fence connected to the controller. Now it would not be practical to adjust the inductance of this coil for a given fence to give resonance exactly, but one coil with several taps could be provided to make it possible to operate near resonance. Each tap could be marked as being suitable for use to produce resonance when the fence length was within some certain number of miles or rods; just how small would be the range for each tap would be determined by service needs and cost. If the inductance as used in the choke coil is L_1 henrys, then the equation for current to the animal or person becomes

$$I = \frac{E}{\sqrt{R^2\left[\left(1-\omega L\left\{\omega C-\frac{1}{\omega L_1}\right\}\right)^2 + R_T^2\left(\omega C-\frac{1}{\omega L_1}\right)^2\right] + \omega^2 L^2}} \qquad [11]$$

For example, let it be assumed that there is to be designed a leakage transformer that *(Continued on page 12)*

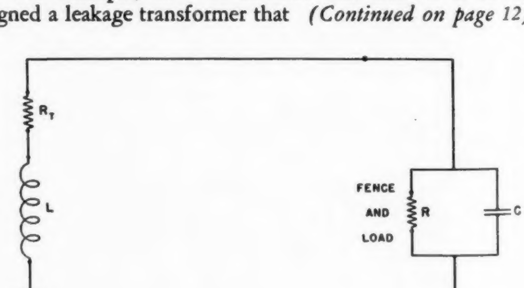


FIG. 8 APPROXIMATE EQUIVALENT CIRCUIT OF HIGH-LEAKAGE TRANSFORMER, ELECTRIC FENCE, AND LOAD

New Uses and Equipment for Electric Heat

By G. E. Mullin, Jr.

THE FOLLOWING is a brief review of some of the uses of electric heat which either have proven successful or show possibilities of success:

Control of Tobacco Blue Mold. Tobacco growers have been experiencing considerable trouble and losses from tobacco blue mold. In some years losses are light, while in others losses are very heavy. For this reason growers are interested in any practical means of insuring them against loss from blue mold.

Various methods of solving the problem have been tried such as (1) sowing greatly increased bed areas, (2) attempting by early seeding and liberal use of nitrates to produce early plants which could be set out ahead of the disease, (3) applying dry sand, dust, or gypsum, or (4) beating the plants with brush.

The U. S. Department of Agriculture working closely with state experiment stations has found three effective methods for controlling tobacco blue mold: (1) Spraying with copper oxide-cotton seed oil mixture, (2) gas treatment with benzol or oxylol, and (3) heat treatment in which night temperatures are raised above 70 F (degrees Fahrenheit).

From work done thus far, the spray method seems to be the most practical. The gas treatment has been tried for only two full seasons, and is rather expensive and complicated for common use.

As very little work has been done with the heat method, there is much need for further experimentation. If beds were built with proper care, soil-heating equipment aided with mats at night should effectively maintain night temperatures above 70 F at a minimum cost.

The electric heat method thus offers possibilities for continued experimentation, and if practical results work out as are expected, soil-heating equipment should be commercially successful in controlling tobacco blue mold, and assuring healthy, vigorous plants.

Control of Foliage Diseases of Tomato Plants. The use of electric heat in controlling leaf spot diseases is of great interest to plant growers and vegetable and flower forcers. Work has been done with foliage diseases of tomato plants by using an electric heater and a fan to circulate the air. Fan type electric heaters and soil-heating equipment are also means of supplying heat under control.

This application of electric heat for the control of foliage diseases is worthy of continued experimentation and development. More work must be done to prove its practicability.

Pig Brooders. Considerable work is being done on pig brooders by the University of California. Its Bulletin No. 618 (December 1937) gives a report of work done by James R. Tavernetti and E. H. Hughes. This shows initial and operating costs of pig brooders to be low enough to make their use economically feasible. In tests made two types were used, the radiant type employing an overhead light as the test source, and the under heat type using heating coils enclosed in a metal box. The results with each were practically the same. The radiant type was simpler, less expensive, and easier to construct. The light attracted the pigs and illuminated the pen; there was less danger of electrical shock; and the amount of heat could be varied by merely changing the size of lamp bulb.

Truman E. Hienton of Purdue University is carrying on experiments at this time and will probably have some further information later.

A considerable number of electric pig brooders are now in successful operation, and are proving to be an economical and practical method of caring for young pigs.

Electric Pasteurizer. Although milk pasteurization in itself is not new, there have been a number of new improvements in methods and equipment which are effective in producing better results.

The old method of pasteurizing required heating the milk in a large tank by steam or hot water to the desired temperature. It was held at this temperature for approximately one-half hour, and then cooled. This was known as the "long hold" method.

The new electric heat method raises the temperature of the milk to slightly over 160 F for 15 sec by passing electric current through it as it flows between electrodes on its way through the pasteurizer. This is known as the "short hold" method.

Automatic equipment gives close temperature control and provides continuous operation as long as there is a supply of raw milk in the storage tank. The power consumption is surprisingly low, since the outgoing milk preheats the incoming milk by means of a heat interchanger. The principal advantages are (1) better milk flavor, (2) less floor space, (3) low operating cost, (4) better cream line, (5) easy cleaning, and (6) simplicity of operation. This electric pasteurizer has been experimented with for about twelve years, during which time many practical tests have been carried out in commercial milk plants.

Present capacities are too large for use on any but extremely large dairy farms, as they are designed primarily for use in milk plants. It is probable that these pasteurizers may be available in smaller sizes at some later date.

Portable Forced Air Heater. Very often there are places where warm air is required for relatively short periods of time. A portable forced air heater is particularly well adapted to meet these needs.

A motor-driven fan forces the air through electric heating units. The heater is available in 2, 3, and 4-kw ratings at 220 volts, and delivers 6,824 btu, 10,236 btu, and 13,648 btu per hour, respectively, at 710, 730, and 750 ft per min average air velocity.

Portable Natural Convection Air Heater. In many instances ordinary strip heaters are desirable for supplying electric heat. A portable natural convection air heater has the advantage of simplicity and convenience, in that it consists of a number of strip heaters already mounted and connected, and ready for use.

The heater is equipped with a three-heat snap switch and a rubber-covered cord so it may be plugged in easily. It is available in 1, 2, 3, and 4½-kw ratings, and furnishes an ideal method of conveniently using electric heat.

Portable Water Heater. For a long time there has been a need for an inexpensive electric heating element which a

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A contribution of the A.S.A.E. Committee on Uses of Heat in Agriculture, 1938.

Author: Rural electrification section, General Electric Co. Mem. A.S.A.E.

farmer or dairyman could use to heat a small amount of water. A portable water heater meets that very requirement. It is rated at 1300 watts, 115 volts, is small enough for a pail of conventional size, and long enough to serve in tanks or barrels up to 30 in deep.

While it is not the ultimate type of equipment which would be installed, it does serve an intermediate purpose which will lead to the eventual use of more electric heat.

Other Uses for Soil-Heating Cable. Many applications have been found for soil-heating cable other than in greenhouses, hotbeds, and cold frames. Among these are uses such as for pig brooders, poultry brooders, keeping water pipes from freezing, melting snow and ice in eave troughs, etc.

It has been suggested that soil-heating cable be laid in the concrete, to melt the snow and ice on sidewalks. This may have possibilities and is worthy of further thought and investigation. Some installations are under observation.

High-Leakage Transformers as Alternating Current Fence Controllers

(Continued from page 10)

is to operate at 60 cycles and deliver an uninterrupted current of 8 milliamperes at short circuit and 90 per cent of this current at a resistance to ground of 50,000 ohms (R in Fig. 8). It is required to know the values of L_1 in a supplementary tapped choke to be used for various fence lengths to keep the performance of this transformer within the range of its performance between no fence and resonance (curves 1 and 3, Fig. 6).

The current at short circuit, which is the maximum possible steady state load current, is found by the equation 7, $I = E/\omega L$, and the current on the curve for no fence connected and no supplementary choke (curve 1, Fig. 6) just at the falling-off point is found by the equation

$$I = \frac{E}{\sqrt{R^2 + \omega^2 L^2}} \qquad [6]$$

Also I according to equation 6, at $R = 50{,}000$ ohms, must equal 90 per cent of the short circuit current according to equation 7.

Therefore, equation 6 divided by equation 7 = 0.9

and $$\omega L/\sqrt{R^2 + \omega^2 L^2} = 0.9 \qquad [12]$$

This can be solved by algebra or trigonometry for $R = 50{,}000$, to give $\omega L = 103{,}000$ ohms and, for $f = 60$ cycles, $L = 273$ henrys.

As the maximum current is to be 8 milliamperes,

$$E/\omega L = 8\text{x}10^{-3}$$
$$E = 103{,}000\text{x}8\text{x}10^{-3}$$
$$= 824 \text{ volts}$$

The resonance capacitance for this inductance is then calculated by using $\omega^2 LC = 1$, from which we get $C = 0.026$ microfarad, approximately. This represents the capacitance of 1¾ mi of fence at 0.015 mf per mile.

Thus, with this design of transformer the performance would conform to the specifications when no fence was connected and the 90 per cent of maximum current or more would be maintained for more than 50,000 ohms grounding resistance for fence lengths between zero and 3½ mi. For fence lengths greater than 3½ mi, the specified current would be maintained only for grounding resistances considerably less than 50,000 ohms.

In order to keep the performance up to or above specifications for fences longer than 3½ mi, we must make use of the compensating inductance. A reasonable way to design this would be to nullify the effect of 3½ mi of fence with an added inductance. Here $C = 3\frac{1}{2}\text{x}0.015$ mf $= 0.0525$ mf, and since $\omega L = 1/\omega C$ we have $L = 1/\omega^2 C = 135$ henrys. With this inductance in the circuit, the performance of the controller connected to 3½ to 7 mi of fence would be identical with that for from 0 to 3½ mi without the compensating inductance. For fences ranging in length from 7 to 10½ mi, we would need an inductance of 68 henrys, and again the performance would be up to or better than the specifications.

Thus the controller would require a supplementary inductance with several taps reading

(1) For fences 0 to 3½ mi long—No added inductance

(2) For fences 3½ to 7 mi long—135 henrys

(3) For fences 7 to 10½ mi long— 68 henrys

The user would be required to set the tap switch or to attach the grounding wire at the value corresponding to the length of fence being controlled, assuming that his fences were about 36 in high and of one strand. The performance would then be as good as the original design called for, and for most cases it would be better. The degree of superiority of the performance over the designed value depends on the size of R_T (Fig. 8). The smaller this is, the better. This means as large a wire as is practical for both primary and secondary and a fairly low flux density in the core.

One sees from this design analysis that for a controller to be as effective for 25-cycle supply as is one designed for 60-cycle service, the inductance used for 25 cycles would have to be over twice as large as that for 60 cycles. This might entail certain difficulties, and the resulting transformer might be quite bulky.

Calculations have been made for various other types of current limiting impedances in place of inductances; namely, a capacitance, a resistance, and a combination of inductance and capacitance, but they present no particular advantages over a high-leakage transformer, except possibly in giving flexibility in setting up experimental equipment to determine the effectiveness of various currents under field conditions. For commercial use other types of impedances have several disadvantages compared with a high-leakage transformer which controls by inductance. With a controller in which the current is limited by a resistance or a capacitance, the best performance will be that for no fence connected. The addition of any amount of fence will give a poorer performance. It has been shown that with inductance control the addition of fence can be made to improve the performance obtained when no fence is connected.

We believe that the next step in developing high-leakage transformers as electric fence controllers should be the testing of a number of such transformers under actual field conditions. A group of transformers having known characteristics should be given actual field tests for cattle-restraining ability under various conditions. The design of suitable fence controllers of the high-leakage transformer type would then be a straightforward engineering design problem.

Low-Cost Hay Drying

By John W. Weaver, Jr. and C. E. Wylie

IN THE nine southeastern states[1] there is an increasingly active soil conservation program now penetrating to the most remote sections of the area. The nucleus of this program is the improvement and protection of soils to be realized in three major steps:

1 The use of fertilizer to provide phosphate, to be supplemented by the use of lime and manure; and the growth of leguminous crops to provide nitrogen

2 The use of cover crops to provide humus and to prevent erosion and leaching of soils

3 Improved methods of tillage, incorporating the use of terraces and contour farming where row crops are essential.

Hay and forage crops are playing an important role in this great program. In 1934 the acreage of all hay and sorghums for forage in the United States increased 6 per cent over that reported in 1929[2]. The expansion of hay in the southern states equalled the increase of the nation as a whole. Annual legumes saved for hay, showing an acreage gain of 210 per cent, was most noteworthy of any of the hay crops during the five-year period while sweet clover and lespedeza hays increased 82 per cent in acreage.

More recent figures[3] show the 1938 production of alfalfa in Tennessee to be nearly three times that of the 1927-36 average, while the production for the southeastern states as a whole was nearly doubled for the same comparative period.

The number of farms in this area is increasing with a resultant decrease in average size from 80 acres in 1920 to 70 acres in 1935. The present average annual production of hay per farm is 7 tons grown on 6.8 acres.

With proper tillage, seeding, and fertilization, the successful growth of the hay crop is relatively certain with an annual rainfall of 50 in. It is evident then that the harvesting of hay is a problem of increasing importance.

Any method of artificially drying hay in such an area must involve low first cost and low operating cost. The system must be of relatively small capacity, requiring no more labor than the present method of harvesting hay. Conventional machinery and equipment should be used and the results in improved quality must be sufficient to justify the investment.

Barn Drying. The first work done in an attempt to design and develop a hay drying system meeting the above requirements has been reported in a previous paper[4]. Briefly, the present system consists of wooden ducts constructed on the floor of a hay mow, over which hay, partially dried in the field, is stored. This duct system is connected to an electrically driven blower located in a small room on the side of the barn; or it may be located on the ground floor within the barn if space is available.

A barn in which one of these systems is installed near Florence, Alabama, is shown in Fig. 1. The small structure on the side of the barn accommodates the blower and motor. Since hay is stored only in the central section of this barn the connecting duct spans the near wing. A double blower on a single shaft is used for this drier to give air capacity needed at lowest cost for blowing equipment. The interior of the completed blower room is shown in Fig. 2. The glassware, hotplate, and balances in left foreground are used to determine moisture content of hay. Air flow is reversible by removing a short section of the horizontal duct and sliding the elbow section to the right. This blower is driven by a 5-hp motor and delivers 12,000 cu ft of air against a static pressure of 0.6-in water column.

The duct system under construction on the hay mow floor is shown in Fig. 3. It is essential that the mow floor be as air tight as possible. A tongue and groove floor is

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Presented before the Power and Machinery Division at the fall meeting of the American Society of Agricultural Engineers, at Chicago, Ill., November 30, 1938.

Authors: Respectively, associate agricultural engineer, department of agricultural industries, Tennessee Valley Authority (Jun. Mem. A.S.A.E.) and head, department of dairying, University of Tennessee.

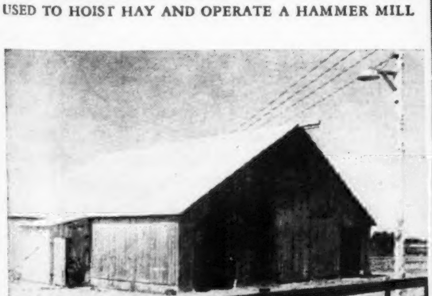
[1]Kentucky, Virginia, North Carolina, South Carolina, Florida, Georgia, Alabama, and Mississippi.

[2]U. S. Census of Agriculture, Volume III, 1935.

[3]Crops and Markets, Vol. 15, No. 9, September 1938.

[4]The Development of a Low Cost Hay Drier, J. W. Weaver, Jr., AGRICULTURAL ENGINEERING, January 1937 (Vol. 18, No. 1).

FIG. 1 (BELOW) BARN HAY DRYING SYSTEM INSTALLED ON MR. ALEX LOCKER'S FARM NEAR FLORENCE, ALA. FIG. 2 (RIGHT) THE COST OF MOTOR AND BLOWERS IS ABOUT 75 PER CENT OF THE TOTAL COST OF DRIER. THE MOTOR IS ALSO USED TO HOIST HAY AND OPERATE A HAMMER MILL



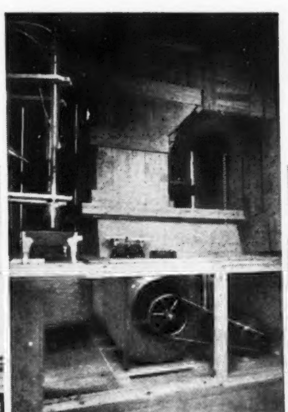
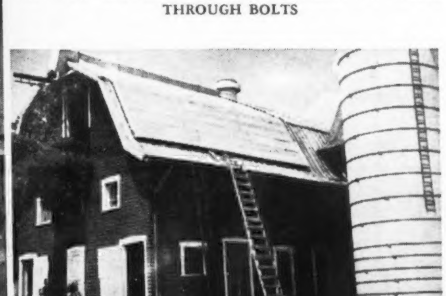
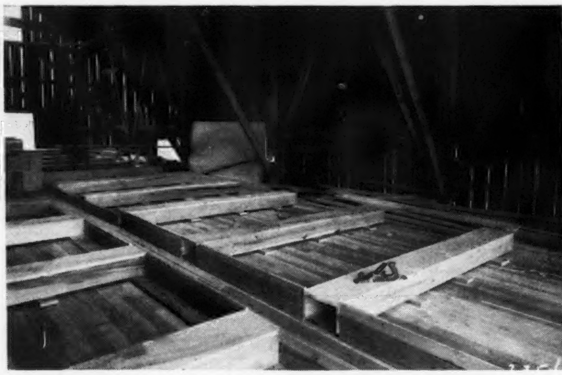


FIG. 5 SOLAR-HEAT ABSORBER CONSTRUCTED ON ROOF OF BARN AT WEST TENNESSEE EXPERIMENT STATION. THE ABSORBER (600 SQ FT) IS FASTENED TO 2x4 SUPPORTS HELD IN PLACE BY NINE THROUGH BOLTS





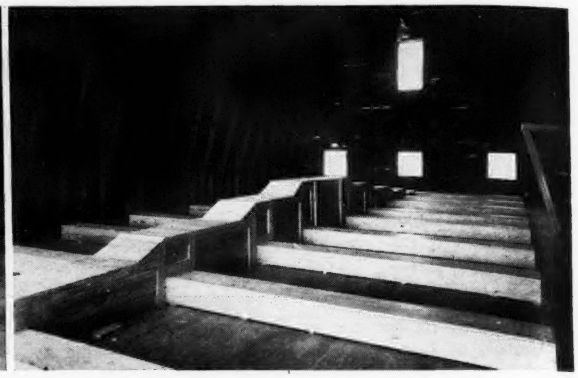


FIG. 3 (LEFT) CONSTRUCTION OF MAIN DUCT AND 12 PAIRS OF LATERAL DUCTS ON MOW FLOOR (26x60 FT). FIG. 4 (RIGHT) COMPLETED DUCT SYSTEM ON MOW FLOOR (30x50 FT) AT WEST TENNESSEE EXPERIMENT STATION, JACKSON

preferable, though a floor of matched boards may be covered with building paper. The completed duct system may be seen in Fig. 4. Air is delivered through the floor to the central portion of the main duct. At this point the air flow is divided, one-half being directed toward one end of the main duct and the other half directed toward the other end. A large gate is located in the center of this main duct so that the entire air flow may be diverted into either half, or into the entire duct system as desired. The main duct is 16 in wide and varies in height and length according to floor dimensions. The lateral ducts measure approximately 8x10 in and extend to within 4 ft of the side walls. These laterals are spaced from 4 to 5 ft apart, depending on the length of the floor. Air is forced from the duct system into the hay through a 1-in opening between the floor and the lower edge of the side wall of the lateral duct. This opening extends the full length on both sides of each lateral.

Solar Heat Absorber. Following the 1936 season, with one exception, no heat has been used to warm the air blown through the hay. A solar heat absorber (Fig. 5) was constructed of 28-gage, galvanized sheet steel on the roof of a barn. By drawing atmospheric air under this absorber, prior to forcing it through the hay, the temperature of this air was increased from 10 to 22 F (degrees Fahrenheit) with a resultant decrease in *(Continued on page 16)*

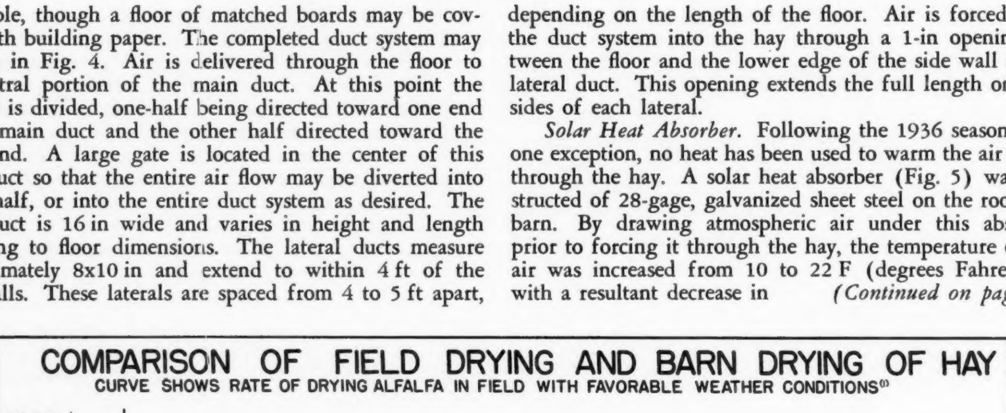


FIG. 6 CHART SHOWING EFFECTIVENESS OF THE SYSTEM AND ITS PRINCIPLE OF OPERATION. MOST GRASSES AND LEGUMES CONTAIN ABOUT 75 PER CENT MOISTURE WHEN CUT, AND MUST BE REDUCED TO 20 PER CENT FOR STORAGE AS LOOSE HAY

Mechanical Equipment for Weed Control

By D. E. Wiant

THE AUTHOR attended a county weed demonstration where four weed control machines were demonstrated and where it was the consensus that a machine designated by the crowd as the "little red machine" stole the show. However, a casual inspection of the machines and field beforehand made it obvious what the results would be, for one machine was entirely out of place and two were not designed to work in a rank growth of leafy spurge. One of the machines cut off only about half of the roots. While another, due to lack of clearance, choked up completely in a few rods of travel.

It was not the mechanical equipment that had failed; it was the machinery dealers. A little foresight in choosing equipment would have resulted in a far more valuable demonstration. The assistant extension agronomist, when introducing the machinery representatives, made the statement that he did not know what machine should be used for leafy spurge. This same man will not hesitate to prescribe a machine and usage for field bindweed, backed up by his own experience, but he feels that further study of the characteristics of leafy spurge is necessary before he can recommend mechanical equipment to control it.

A study of the various types and makes of mechanical equipment is not sufficient. It is necessary to study the root system and growth characteristics of the weed as well. Possibly the agronomist or botanist will need be consulted. Also, the type of farming should be considered. To be satisfactory the mechanical equipment must (1) do the work, (2) be versatile, if possible, and (3) do the work at a low cost per acre. This is but half of the story, for, having chosen satisfactory mechanical equipment, its proper use will determine how successful the results will be.

For example, let us consider a machine to be used on an area infested with field bindweed. First of all, the machine must do the work. Field bindwood, a deep-rootd perennial, has growing habits such that it is able to survive and spread under ordinary farming conditions. All the roots must be cut off several inches below the surface. The mechanical equipment, in order to do the work must, therefore, have penetration and be so designed that the shovels or blades will not clog up or skip any roots or stems. The shovels or blades must overlap. The roots of field bindweed contain stored energy sufficient to keep them alive a whole year or two, even though no top is allowed to grow and replenish the roots. Therefore many cultivations are necessary, and repeated use of the machine must not pulverize the soil so that it will blow or dry out excessively. The duckfoot shovel has the necessary qualifications. It will cut the roots at a depth of 4 or 5 in and work the stems to the top so that they will sun-kill. This type of shovel works the clods to the top and lets the fine soil sift down, leaving the surface rigid with clods and trash on top, in good condition to catch moisture and to prevent blowing.

Presented before the Power and Machinery Division at the annual meeting of the American Society of Agricultural Engineers, at Asilomar, Pacific Grove, Calif., June 30, 1938.

Author: Assistant professor of agricultural engineering, South Dakota State College. Assoc. Mem. A.S.A.E.

The duckfoot cultivator is versatile. It can be equipped with narrow shovels (quack shovels) and will dig out and work the roots of weeds such as quack, to the surface. It is an excellent summer fallow machine. If a deep-furrow drill is used, the drill can be equipped with duckfoot shovels and used as a weed control machine.

Cost per acre depends on other uses that can be made of the machine, its original cost, its draft, and its rate of doing the work.

This means that the machine should be used wherever it will serve efficiently. In purchasing equipment the width should be such that power is used efficiently. This may mean an adjustment between width of machine, depth of penetration, and rate of travel. H. E. Murdock, in his Montana State College Bulletin No. 344 ("A Study of the Operation of Tractors and Implements Under Farm Conditions"), shows that the draft of the duckfoot increases approximately 25 per cent when the depth is increased from 4 to 5 in. Mr. Murdock also states that there is a tendency for the draft of the duckfoot, per foot of width, to decrease as the width increases, and that the draft per foot of width increases 3.2 per cent for an increase in speed of one mile per hour. Obviously then, the width of cut should be sufficient to eliminate the necessity of using higher speeds to get an efficient load. But the investment factor must be considered at the same time. Possibly equipment already in use can be converted into weed control equipment.

Having chosen the mechanical equipment, its proper use for weed control must be considered. Factors involved include (1) preliminary preparation of the ground, (2) the time to start cultivation, (3) depth of cultivation, (4) frequency of cultivation, and (5) subsequent treatment.

For preliminary preparation of the ground, continuing with field bindweed as an example, the Fort Hays (Kansas) experiment station recommends plowing with a moldboard plow to a depth of 6 in before the duckfoot is used. The idea is to get the ground in condition to work with the duckfoot cultivator. If there is a heavy growth of weeds it may be necessary to cut them before starting with the duckfoot. In general, the condition of ground and amount of weed growth will determine what preliminary work is necessary.

Eradication should start in the spring. Food reserves are lower then than at any other season, and soil moisture conditions are more favorable to the rapid growth of the weed.

In the experiments at Fort Hays, 8-in and 12-in depths of cultivation have proved little, if any, more effective than 4-in depths, and the number of operations required has been only slightly less.

Formerly it was quite generally recommended that cultivation be repeated often enough to prevent any growth above the ground. Recent experiments show that better results are obtained when the bindweed is allowed to grow several days above the ground after each cultivation. At Hays the results have been best when the bindweed was allowed to grow 8 days after each emergence. On the average, only 15 cultivations were required to eradicate bind-

weed when it was allowed to grow above the ground 8 days, and 19 when it was allowed to grow 4 days. When the bindweed was cultivated the day it emerged, 26 cultivations were required. However, when top growth was allowed for 12, 16, and 20 days between cultivations, a longer period of time was required for eradication, and in some cases there were some bindweed plants left after two years of treatment. Recent root studies at Hays showed that food reserves in bindweed roots decreased very rapidly during the first 8 to 12 days of top growth, thus leaving the plants weaker than they were at first emergence.

Conclusions in regard to subsequent treatment of land that has been subjected to weed control by mechanical equipment vary according to locality. South Dakota recommends following a season of tillage with rye, Dr. Wilson of the Minnesota Experiment Station suggests winter wheat, while Fort Hays Experiment Station recommends sudan grass or sweet sorghum. Studies along this line are being continued.

I have made no attempt to review the long list of mechanical equipment for controlling weeds, but have undertaken to show that, before recommending mechanical equipment and its use for control of leafy spurge, for instance, or any of our "newer weeds," we must study them just as diligently as field bindweed has been studied. Then, knowing what is required of the mechanical equipment, we can choose the logical equipment for the job.

The department of agricultural engineering, South Dakota Agricultural Experiment Station, with the idea of designing a weed control machine from a machine found on most farms, built one out of the regular two-row horse-drawn cultivator. This machine is to be used where the infested area is so small as not to justify the purchase of mechanical equipment. The gangs and shanks were so spaced that, with an extra shovel mounted between gangs, an 8 to 8½-in spacing was obtained. The gangs were held in position and the machine strengthened, at the expense of flexibility, by bolting two braces across the gangs. Duckfoot shovels, 10-in size, were carefully set. The machine showed up, in a series of weed machinery demonstrations, as satisfactory for field bindweed control as a $135 field cultivator. When quackgrass shovels were substituted for duckfoots, it proved to be satisfactory in quackgrass control. Although this machine lacks clearance, careful planning in its use eliminates any trouble from choking up. The original two-row cultivator can continue to serve as a cultivator, as well as weed control machine, by making the conversion whenever necessary. Any farmer can make the conversion.

L. C. Aicher, superintendent of Fort Hays Experiment Station, went to considerable trouble to show me the most popular machine on the 6200-acre farm. This is a weed control machine or "bindweed machine," as they call it, made from a one-row cultivator. This machine, equipped with seven 9½-in duckfoot shovels and pulled with horses, is used by every department on the farm. It is used to control weeds in small areas and is very efficient in field bindweed control.

Low-Cost Hay Drying

(Continued from page 14)

relative humidity of about 1.5 per cent for each degree rise in temperature.

Automatic Control. The development this last season of an automatic control for the system looks very promising. This control, briefly, consists of a humidistat, located outside the barn, and a thermostat, the bulb of which is inserted in the hay. These devices are connected in the control circuit of the motor starter. Thus as outside relative humidity rises when the sun sets the blower is stopped. If the hay heats abnormally during the night the blower operates just long enough to remove this heat. The next morning as relative humidity falls with the rising sun, the blower is again started. A thunder shower will stop the blower until air conditions are right for further blowing.

Effectiveness of System. The effectiveness of the system compared with the present method of harvesting hay is illustrated in Fig. 6. The curve in the upper portion of the figure shows the moisture content of alfalfa hay from the time it is cut at 9:00 a.m. of the first day until it is ready for conventional storage in the barn at 4:00 p.m. of the second day. Observations have shown that loose hay of more than 20 per cent moisture content cannot be stored without undergoing considerable heating and deterioration in quality. The barn-drying system can adequately complete the drying of hay of 45 per cent moisture. Thus, with favorable weather conditions, 31 hr are required to completely dry alfalfa hay in the field. Only 4 hr of field drying are needed to dry the hay to a point when it may be stored on the barn drier, where drying is completed in from four days to two weeks.

After the first cutting or layer of hay has been dried, the second cutting is stored upon the first, and the third cutting upon the second. Observations show that the maximum height to which hay may be stored on the barn drier is about 10 ft after settling. No more than 6 ft of hay should be stored on this drier at one cutting.

Samples of hay analyzed by the hay, feed, and seed division of the U.S.D.A. Bureau of Agricultural Economics show barn-dried hay to average 2.3 per cent more leaves, 19 per cent more green color, and a quality of about one grade and class better than field-dried hay cut from the same field at the same time. Feeding trials of the two hays[5,6] showed very little difference in animal weight gain and growth when fed to dairy heifers and 2-year old steers. When fed to rats, the barn-dried hay apparently contained about three times more vitamin A than field-dried hay.

Investment and Operating Cost. With an investment of about $300.00 for blower, motor, lumber, hardware, and labor a barn can be equipped for drying an annual crop of 20 tons of hay. The cost of operating this system, exclusive of labor, in drying about 200 tons of hay during the last three seasons has averaged 86 cents per dry ton, with electricity available at 2 cents per kilowatt-hour. Records show the labor requirements for the barn-drying system to be about the same as for the conventional method of field drying. More labor is required in storing hay on the barn drier than in regular barn storage, whereas when bad weather is encountered more labor is needed in the field to complete the field drying of hay.

[5] Air Dried Hay for Dairy Heifers, C. E. Wylie, S. A. Hinton, and J. W. Weaver, Jr., Mimeo. Report No. 44, Dairy Dept., University of Tennessee.

[6] Steer Feeding Experiment, M. Jacob, B. P. Hazlewood, and H. R. Duncan, 1937-1938, West Tennessee Experiment Station, Jackson, Tennessee.

Flood Control in Soil Conservation

By W. C. Lowdermilk

THE Omnibus Flood Control Act of 1936 with subsequent amendments is the culmination of a long period of dealing with flood waters from eroding landscapes. It represents another important forward step of the federal government in dealing with floods. Together with the Soil Conservation Act (Public H. R. 738, 74th Congress) of 1935 and the Agricultural Conservation and Domestic Allotment Act of 1936, it marks the beginning of a new era in the relation of the American people to their land and water resources. The concept of conservation of natural resources was crystallized in 1908 by the Congress of Governors called by President Theodore Roosevelt. At that time, however, the emphasis was placed upon forest resources. The menace of soil erosion to basic soil resources was given minor attention, for it was understood or appreciated by few of the leaders of thought. It required a generation for the nation to come to a realization of the true nature of the menaces inherent in soil erosion to bring about further action by Congress, to provide for a full-fledged program of conservation of the basic resources of soils and waters.

While the soil conservation acts of 1935 and 1936 provided for the preservation of soil and control of accelerated erosion in the interests of flood control as a supplemental objective, they did not provide for the undertaking of action programs on the land in the interests specifically of flood control. For fully a half century Congress had provided for flood control measures in levees and flood detention dams on major streams, but such programs provided in no way for measures to retard runoff, to control erosion, and to reduce the production and accumulation of erosion debris in stream channels and reservoirs. The influence of the condition of the land surface on erosion and storm runoff had in no way been taken into account in provisions for flood control; nor was action to this purpose authorized by Congress, prior to the Soil Conservation Act, except to provide in the Weeks Law for enlargement of national forest areas by purchases.

Thus the Omnibus Flood Control Act of 1936 authorizes, for the first time in the history of the country, a coordinated land and water program for flood control. Amendments in 1937 and 1938 further extend the scope of the law. It recognizes that the social security of the people involves protection of favorable conditions of water control and conservation on the land of catchment basins as well as in the protection of valley lands subject to overflow in flood stages of rivers. These acts call for treatment and control of runoff waters from the rain drop to the raging torrent.

The floods of 1927 in New England, of 1936 in New York and Pennsylvania, and of 1937 in the Ohio Valley served to activate the public consciousness to the need for action. The muddy flood waters and the remarkable accumulations and deposits of silt, which were known to be made up chiefly of soil washed from eroding and wasting farm fields directed attention to the need of works on the land as well as works in stream valleys. Furthermore, the measured results from 17 soil erosion experiment stations had made known the significant fact that cultivated slopes yield many times as much immediate surficial runoff as grass covered or forested slopes. Moreover, land under treatment for erosion control and soil conservation yielded less runoff than fields without such protective measures. Evidence had been piling up so that these serious floods galvanized the nation into action, calling for a comprehensive program of flood control to consider the problem as a whole. Congress called for a complete solution to flood control problems, or as complete as it is possible for man and his works to provide. Few acts of Congress will be more far-reaching in their influence on maintaining the foundations of our civilization.

The Act authorizes and directs the Secretary of Agriculture to make surveys, as funds are appropriated, "for runoff and water flow retardation and soil erosion prevention on watersheds on which the Corps of Engineers has been authorized to make flood control surveys and to construct flood control works." This authorization calls for surveys, preliminary and detailed, and estimates when justified, on drainages of the United States equivalent to 80 per cent of the total land area. In short, the authorization to the Department of Agriculture calls for a vast program and a stupendous enterprise in safeguarding the soil and water resources of the nation.

Flood waters originate on the land surface, not in the stream channels. Hitherto flood control and prevention measures have been devoted wholly to flood waters after they have accumulated in stream channels. The intake

An address before the annual meeting of the American Society of Agricultural Engineers at Asilomar, Pacific Grove, Calif., June 29, 1938.

Author: Chief, soil conservation research, Soil Conservation Service, U. S. Department of Agriculture.

capacity or infiltration capacity of the land is coming to be recognized as an important factor in flood flows. Accumulating experimental evidence shows that this infiltration capacity may be modified in significant amounts by land treatment. Retardation of surficial runoff may be effected by increasing and maintaining intake capacity of a soil, by furnishing surface detention, and by providing depression storage. But the application of measures to these ends are not as simple as they appear.

Flood control measures on the land—the gathering grounds of flood waters—coincide with soil conservation and erosion control measures. It becomes a nice question, therefore, as to where the line should be drawn to separate measures and practices which may be justified in the interests primarily of soil conservation from those primarily in the interests of flood control. Furthermore, many important questions arise as to the effect of different kinds of land use on rates and amounts of storm runoff and flood flows. These and related questions require answers for the safe and sound development of the flood control program on the land over a vast area.

The American people have long been committed to the expenditure of hundreds of millions of dollars for flood control. Such commitments will increase rather than decrease. It is the part of wisdom to provide and amplify a body of reliable information as rapidly as possible to keep pace with increasing demands required by the land use, flood control program as it is broadened and extended over the country.

This increased responsibility for flood control now placed in the Departments of War and Agriculture is the culmination of a long list of responsibilities delegated in the past by Congress. The Corps of Engineers has been engaged for more than 50 years in the improvement and control of major rivers and waterways in the United States. Its records of achievement are praiseworthy. In like manner, the Department of Agriculture since 1862, in cooperation with state colleges and experiment stations, has been conducting research which has supplied the foundation of prevailing improvements in land use in the interests, primarily, of increased crop production as well as of soil conservation. And for the past 30 years the Department has been administering soil and moisture programs of enlarging proportions.

The major engineering aspects of flood control have been advanced more rapidly than the land-use aspects, primarily in the interests of immediate protection of property and lives on the flood plains. Such necessary measures are now to be supplemented and safeguarded by providing for treatment of the land, the gathering grounds of flood waters. The nation has committed itself to a complete program of flood control.

So complex, however, are the interrelations between land use and storm runoff, water conservation, and flood control, that only a beginning has been made toward a full understanding of these problems. A few important discoveries have been made, but much is yet to be known in order to provide the answers which a program of such gigantic proportions as now authorized must have in the interests of efficiency and economy.

The complexity of the problem is known to students of hydrology and flood control. Yet the factors in determining the influence of land use on flood flows may be grouped into three major categories: (1) the absorption and retention characteristics of the land, (2) the concentration of unabsorbed waters from drainage channels into trunk streams under variable rainfall patterns, and (3)

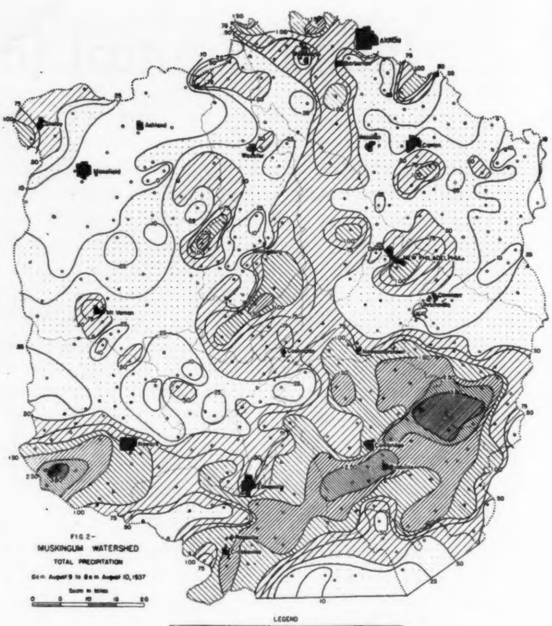


FIG. 2— MUSKINGUM WATERSHED TOTAL PRECIPITATION

the accumulation of erosional debris in stream channels and reservoirs.

These three categories are so different and complex in their effects that unless they are examined and evaluated separately for their respective parts in producing flood flows, our investigations will lead to confusion and unreliable results. In early runoff studies, beginning with the Basin of Ru de la Grenetiere by the famous engineer, Belgrand, nearly a century ago, feeble were the attempts, if at all, to isolate and study such factors separately. As a consequence, citations are made to conclusions in literature based upon studies which can not be fully relied upon. The results are divergent, and conclusions are conflicting as well. Within the decade a number of important studies have been undertaken with promise, but only a beginning has been made, as is evidenced by the publication of "Deficiencies in Basic Hydrologic Data," by the National Resources Board (1936).

Significant information on the first factor, namely, the absorption and retention capacity of the land, is being built up by a series of studies conducted by federal, state, and private agencies. These studies are yielding information primarily on the infiltration rates and capacities of various soils under different conditions of slope, erosion, and use. A sample of this type of information is given in the accompanying graph.

Results in runoff from heavy rains from four soil erosion stations located in diverse regions show remarkable uniformity. The differences are large, which leads to the conclusion that the surface condition of the land plays an important role in the immediate intake of precipitation waters. It is not necessary here to cite all the numerous studies which are yielding information on the influence of land use on runoff and erosion.

Such large differences in runoff intensity are not likely to be found in major trunk streams because of a number of reasons as will be discussed below. It was the apparent discrepancy between measurements of runoff from experimental plots and small areas, and the measurements of

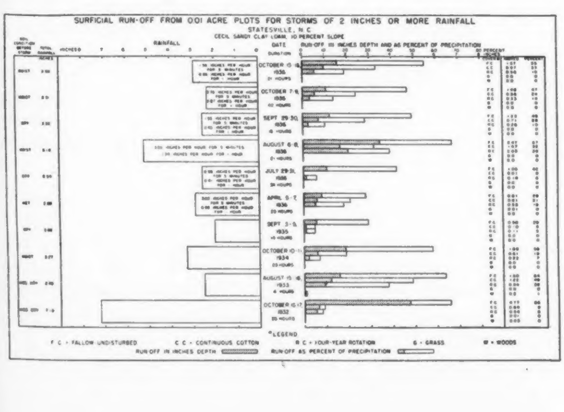
flood stages in large streams that gave rise to a controversy lasting nearly a century. The point at issue has not yet fully been settled, but progress is being made.

If the influences of small areas were additive throughout an entire drainage area, the flood control engineer would find decisive evidence at gaging stations on trunk streams. Instead of being additive, however, flood flows are products of many factors of plus and minus values. Diversity of soil, slope, and surface conditions level out differences. Where crop rotations are practiced, infiltration capacities may vary as widely as they do on plot experiments. Consequently, the effects observed on isolated plots or fields are more or less masked and modulated on larger areas, but they nevertheless exist on the individual units of these large areas. The menace inherent in an eroding part of a drainage may thus be masked in the compensated flow of the major stream. Stream gaging in major streams generally can not be relied on as an indicator of the influence of land use on flood flows, without an evaluation of contributing factors.

The second category includes factors which determine the concentration of flood flows in a system of drainage channels. It is the most elusive aspect of flood flows, and difficult of evaluation. I mean to say that in considering the influence of land use on flood flows, variations in the accumulation of unabsorbed waters in tributary channels has been too much overlooked in past investigations. Such variations, for example, may be due to channel storage, to synchronization in discharges of tributaries, or the lack of it, and to differential travel of flood waves as compared to rate of streamflow. Unless this mechanism of a flood flow is fully examined we may be misled in our conclusions from stream flow measurements. And furthermore, superimposed upon an intricate drainage pattern are rainfall patterns, which can never be assumed to be the same, storm after storm, either in location, extent, or intensities. Many are the possible combinations of factors causing flood stages, as may be judged from Figs. 1 and 2.

It thus becomes apparent that unless the effects of these several responses to rainfall and land-use patterns are taken into account, misleading conclusions may be drawn from plot measurements, as well as from major stream gagings. The omission of this phase of flood flow accumulation may be cited as the principal cause in the past for differences in conclusions of honest investigators. A more thorough analysis of flood flow problems by Sherman, Horton, Bernard, and others has disclosed the significance of the factors determining concentrating of flow. We are prepared to proceed with investigations already planned and under way with much more confidence of significant results.

When the behavior of storms and their patterns of intensities and amounts, location, and extent are known;



when the characteristics of channel storage and flood flow accumulations are charted, we are in a position to follow the influence of surface conditions from plots and small drainages to large drainages.

It should also be noted that the immediate runoff has been found to have a profound influence upon the amount of erosion, and upon its sorting and removal down slope into drainage channels. Sedimentation caused by erosion introduces the third category of factors of the influence of land use on flood flows, the accumulation of sediments in drainage channels and reservoirs. Eliassen, after 17 years of study and work in flood control of the North China rivers, came to the conclusion that a heavy silt burden in runoff will in time nullify engineering works of flood control.

The accumulation of erosional debris as deposited silts and bed load shoals, is one of the most serious menaces to the lasting effectiveness of flood control works. Unlike storm runoff which, except for evaporation and stream bed and bank infiltration, makes a nonstop trip to the ocean, most of the erosional debris as heavier particles progresses downstream in innumerable stages. Flood flows swell and pass on, but sediments accumulate gradually or exceptionally in one storm, as in the southern California flood of March 1938, to change channel and storage capacities. Silt and sediments as products of accelerated soil erosion can not be omitted from consideration in any flood control project.

Thus there is an urgent need for a body of knowledge on the land-use phases of flood control, comparatively new to agricultural science. The development of this science is a responsibility of the Department of Agriculture and cooperating state agricultural colleges. The opportunity has arrived. To take advantage of the opportunity will involve adjustment in interests or curricula in a few institutions, but for the majority of agricultural colleges it will call for a distinct orientation of interests, research, and instruction to meet the requirements of full cooperation with the Department.

The work of the Department of Agriculture under the Omnibus Flood Control Act is being carried out in a number of steps. The first is to make preliminary examinations of a number of important watersheds. Such surveys set forth characteristics of a drainage as to rainfall, topography of the drainage basin, the land-use economy, soils, land-use practices, flood and erosion history. From these findings drainages will be selected for further detailed surveys.

The detailed survey will furnish the basis for a report to Congress by the Secretary of Agriculture for an action program. Thus the detailed survey will serve as the basis for a control plan when appropriations for such purposes are made.

Questions peculiar to each drainage on infiltration rates and capacities of different soils, on slopes of different gradients, under different crops, and over different geological formations will need to be answered to plan measures and practices to be used. Some such questions may be answered by extensive studies on the land of a particular drainage. Other questions, however, will be too complex to answer in such manner; they will require study under controlled conditions at an experiment station or a land-use hydrology watershed study.

The action and research programs are being closely coordinated. Work at the field experiment stations is being made responsive to the needs of action programs under the Flood Control Act. In a similar way, the field operations are being made responsive to the findings of the field research stations. Research findings of field research sta-

tions will be and are put to trial in field tests out on the land in operations projects or district areas. The researcher and the operations project officer are expected to plan and to carry out the field tests together. In this way, the findings of research may be applied to the land in accord with its needs and adaptabilities, in the interests of flood con trol as well as of soil and water conservation.

Not only will the detailed survey take into account the technical problems, but the economic and social as well. The factors which influence or control land use must be given due weight in formulating an action program, drainage by drainage. The basis for recommendation for action programs is being established on estimates of flood damages and expected prompt and long-time benefits of erosion and flood control. Such estimated benefits are not necessarily based on current values of land and improvements subject to damage by floods. Current selling prices of land and improvements are not adequate to a long-range flood control program. What can be justified now is no measure of what can be justified in the future.

Land with its waters is the life of a nation; it is the principal source of the food supply of a people. The United States is still exploiting its land resources; but the Soil Conservation, Domestic Allotment, and Flood Control Acts have set forth national objectives and policies toward conservation and flood control as a long-range venture, extending beyond current economics.

Such considerations, however, do not imply that unlimited funds can be justified now for erosion and flood control. It does mean that we must be looking ahead; that a line can be drawn between two types of land, one which justifies funds for maintenance in cultivation, and one for which funds can not now be so justified. In the second case, the solution under existing conditions would be the rededication of the lands to some less intensive use, such as pasture or forests.

In these respects, the United States is moving toward national, state, and local cooperation in land and water-use problems. Flood control and water conservation is being given its logical place in this national effort. Such cooperative undertaking is being provided for by acts of state legislatures of a state soil conservation districts law, under which legally constituted districts are set up to cooperate with the Department in soil and water conservation and in flood control.

There is being set up the machinery and procedure to advance the general use of measures and practices of land use to conserve the basic soil and water resources, and to give possible control of storm waters and flood flows. Application is being provided for, however, at rates which outdistance the means for supplying in advance the reliable and needed information to guide in an efficient and economical program of works on the land. This situation is a challenge to the Department and to the agricultural colleges. It has been easy to get support for researches in fertilizers and for new uses for agricultural products and for marketing of such products, and in recent years it has been easy to get support for action programs on large scales. On the other hand, it has been more difficult to support scientific studies necessary to supply in the shortest possible time the answers to questions insistently arising in the application of the best we know to the land. Too little attention and support have been given to studies for maintenance of the integrity of the soil resource, and for the control of waters where they fall.

Too little is known about methods in conserving rainfall, in increasing intake capacity of soils under cropping and pasture use, in reducing the production of silt. There is an urgent need to develop the science and practice of water conservation and control to meet the needs of this vast undertaking of flood control on which the American people are destined to spend hundreds of millions of dollars. Such expenditures, to be fully justified, must be in accord with natural laws which must be distilled out of complexities of natural phenomena. Economy and prompt effectiveness of the undertaking calls for a body of reliable information established as rapidly as necessary additional studies can be established and made to yield results. The development of researches into agricultural hydrology, or the influences of land use on water economy, on storm runoff, silt production, and flood flows, waits on the participation of agricultural colleges, including the engineering profession with the Department and its services.

I am sure that the opportunities for science and for contributions to the national welfare are recognized by foresighted members of the engineering profession. The possibilities are great in terms of the support which the American public will give to flood control throughout the land. And I feel confident that the engineering profession will not overlook these opportunities, nor fail American agriculture in taking its part to meet the urgent needs of science and practice in the control of flood waters through land use.

LITERATURE CITED

Bernard, Merrill M. Giving a real significance to hydrologic research on small areas, headwaters control and use. Report on Upstream Engineering Conference, U. S. Dept. of Agric., Soil Conservation Service, Forest Service and E.R.A. Coop., 1936.

Hayes, O. E. and Palmer, V. J. Soil and water conservation investigations, progress report, 1932-35, LaCrosse, Wisconsin, U.S.D.A. Soil Conservation Service, Sept. 1937. Mimeo.

Hill, H. O., Elwell, H. M., and Slosser, J. W. Soil and water conservation investigations, progress report, 1930-35, Red Plains Soil Conservation Experiment Station, Guthrie, Okla. U. S. Dept. of Agric. and Soil Conservation Service, July, 1937. Mimeo.

Horton, R. E. Preliminary outline for a comprehensive research on runoff phenomena, W.R.C. Hydrologic Research, File No. 2, 1938. Mimeo.

Sherman, L. K. Hydrographs of stream flow and their relation to precipitation and basin characteristics. Washington, D. C., 1937. Mimeo.

National Resources Board, Deficiencies in basic hydrologic data. National Resources Committee, Sept. 1936.

The 1939 AAA Farm Program

THE 1939 program sets up a national soil-depleting goal of between 270 and 285 million acres, which is about 5 million acres less than the 1938 goal and roughly 30 million acres less than the acreage of soil-depleting crops grown during the 1928-32 period. Under the conservation phases of previous programs a good part of this former acreage in soil-depleting crops has been put to soil-conserving crops or handled so as to prevent erosion of various kinds. The difference in acreage of soil-depleting crops sought in the 1939 program and that in the 1928-32 period represents in part the fundamental adjustments which the loss of export markets, increased mechanization of agriculture, and other changes have forced upon American farmers and which the AAA programs have sought to bring about in an orderly fashion.

The 5-million acre reduction from 1938 largely represents the smaller wheat goal which the 1939 program provides. Goals for the other major crops are virtually the same in the new program as they were in 1938, indicating that individual farm allotments will be very similar to what they were in 1938.—From "The Agricultural Situation," for December 1938.

An Internal-Combustion Nut Cracker

By Roy Bainer and C. E. Barbee

APPROXIMATELY one-half of the 70,000,000 lb of English walnuts produced annually in California are sold as shelled nuts. The cracking of these nuts and the separation of the nut meats from the broken shells is a tedious task in which both machines and hand labor are now used. Present practice is to first pass the nuts through a mechanical cracker adjusted so far as possible to rupture the nut walls with as little injury as possible to the meat lobes. The cracked nuts are then delivered to picking tables where the meats are separated by hand labor.

Th tediousness of this task is illustrated by the output of the worker, which averages about 35 lb of meat per worker per day. This low output per worker naturally increases the cost of shelled nuts to consumers and likewise tends to limit the market.

The California Walnut Growers Association, desirous of expanding its market, asked the California Agricultural Experiment Station to investigate possible methods of nut cracking which might offer promise of being more economical of labor.

All nut crackers, of necessity, must operate on a differential pressure principle. The crackers now in use, and which have been developed after twenty years of actual cracking experience, use the principle of applied external pressures, thereby crushing the shell toward the meat lobe. This limits the degree of crushing to the free space between the shell wall and the enclosed meat, otherwise the nut kernel is damaged, with loss of marketability. Due to these limitations only partial cracking takes place, resulting in hand work to separate the meat lobes from the shells.

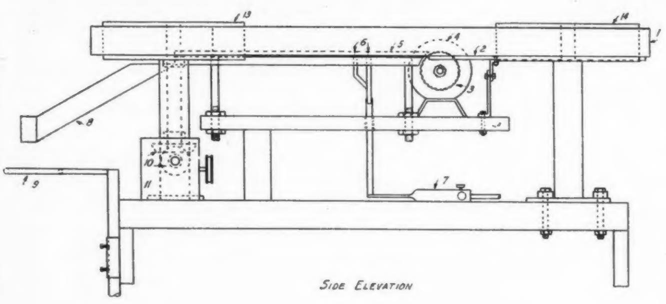
Since external forces had been quite well explored as a means of cracking nuts, it occurred to the experiment station workers that some thought should be given to the possibilities of creating differential pressures on opposite sides of the nut wall by some internal force. Naturally, the use of some explosive gas injected into the nut cavities suggested itself as a result of this approach. Preliminary experiments readily showed that the injection of an explosive gas with subsequent ignition set up a force sufficient to shatter the nut walls and fortunately the kernel or meat lobes remained relatively intact. Moreover, the force of the explosion, being inwardly toward the meat lobes and outwardly toward the shell, caused the former to drop relatively free from the shells which were thrown some distance away, thereby effecting a degree of separation.

The results of these preliminary studies looked so promising that a decision was made to build an elemental machine employing this principle. While the authors designed and built the elemental machine herein described, acknowledgment is due A. S. Leonard, H. B. Walker, and F. G. Hall of the division of agricultural engineering for assistance in conducting the preliminary work.

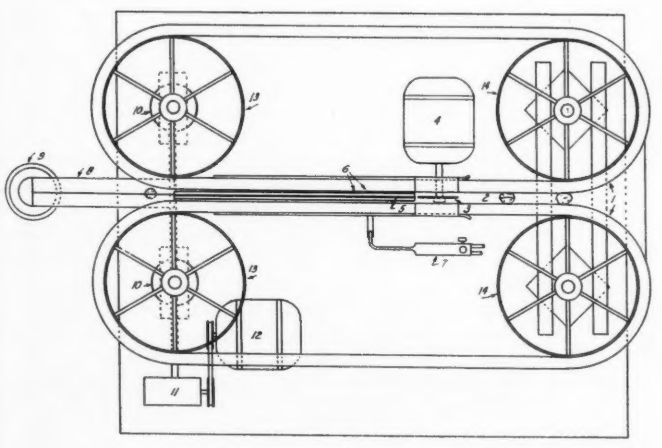
The purpose of the machine is to puncture or cut the nut shell, then introduce through this shell aperture, an explosive gas mixture to fill the space between the shell and the kernel of the nut, and lastly to explode the gas to shatter and separate the shell from the kernel.

In the machine two rubber-faced belts were driven and guided by pulleys operated on vertical shafts. These belts convey, hold, and guide the nuts through the machine, causing them to pass over a small circular saw for cutting a slot or aperture through the shell, after which the nut is conveyed over and along a guide rib that partially fills the slot made by the saw. Vertical openings extending through the horizontal guide rib provide a means for introducing the

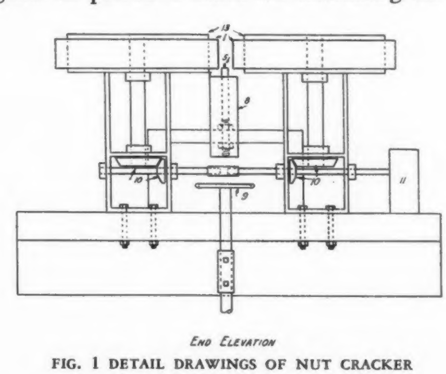
Authors: Respectively, associate professor of agricultural engineering and associate agricultural engineer in the experiment station (Mem. A.S.A.E.), and associate with experiment station, University of California.



SIDE ELEVATION

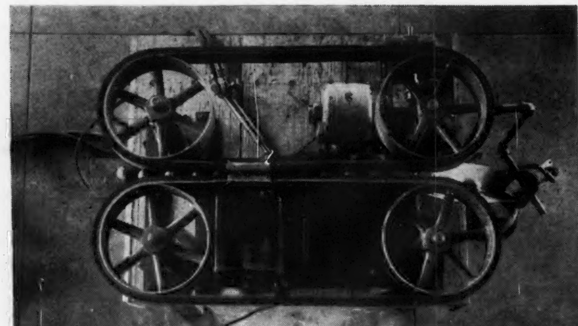


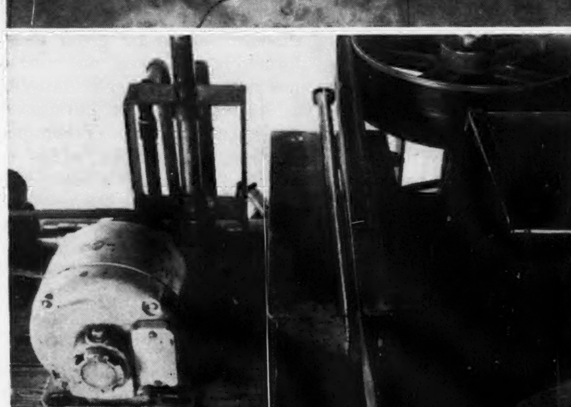
PLAN



END ELEVATION

FIG. 1 DETAIL DRAWINGS OF NUT CRACKER





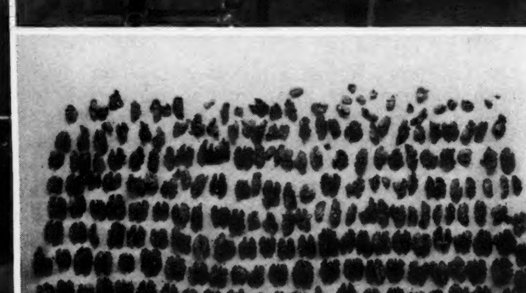


FIG. 2 (UPPER LEFT) PLAN VIEW SHOWING WALNUTS BEING CARRIED BETWEEN RUBBER-FACED BELTS. FIG. 3 (UPPER RIGHT) DISCHARGE END OF CRACKER, SHOWING DELIVERY OF GAS-FILLED NUTS TO THE FLAME. FIG. 4 (LOWER LEFT) ONE BELT REMOVED TO SHOW DETAIL VIEW OF SAW AND GUIDE RIB. FIG. 5 (LOWER RIGHT) MEATS FROM A SAMPLE OF WALNUTS CRACKED BY EXPLOSION

explosive gas mixture into the nut. Mixing valves are provided for proportioning the gas mixture and a flash or spark gap is located near the end of the horizontal guide rib to ignite the gas within the nut immediately after it leaves the rib and is released by the rubber-faced belts.

Referring to the drawings (Fig. 1), it will be seen that two parallel belts (1) running in a vertical position and at a speed of 110 fpm convey the nuts through the machine. An adjustable saw table (2) regulates the depth of the saw cut through the shell. A slot 0.065 in wide is cut through the shell as the nut moves over the circular saw (3) which is driven from a shaft of an electric motor (4).

Upon leaving the saw the nut, guided by the belt (1), rides on a guide rib 0.055 in wide (5) which partially fills the slot cut by the saw. Apertures, 0.050 in in diameter (6), through the guide rib admit the explosive gas to the nut from the mixing valve (7). The nut continues to ride along the guide rib (5) which now seals the slot in the nut, thus retaining the gas within.

The gas-filled nut is discharged from the belts onto a slide (8) which conveys it to a flame (9) where ignition takes place. The resulting explosion shatters the shell.

Advantage may be taken of the force of the explosion for making a partial separation of the nut kernels from the broken shell by having two concentric receptacles below the flame, one to receive the nut kernel as it tends to drop downward after the explosion, and the other, a larger one, to receive the shell which is thrown out laterally due to the force of the explosion.

In some preliminary trials ignition was accomplished by means of an electric spark imposed across a gap at the termination of the guide rim. While this method of ignition was satisfactory, the nuts were still between the belts, so the shells could not be blown away from the meats.

The belts (1) are driven by pulleys (13) and run over idling pulleys (14). The pulleys (13) are driven through a set of bevel gears (10) mounted on the shaft of a speed reduction unit (11). An electric motor (12) furnishes power to the speed reduction unit.

Approximately 60 per cent of the nut meats come out in whole or half pieces, while the balance are in rather large pieces. Allowing 2 in per nut, this machine has a potential capacity of approximately 900 lb of unshelled walnuts per hour.

The gas mixture used in the preliminary trials consisted of an explosive mixture of oxygen and acetylene. No determinations were made of the quantity of gas used. However, calculations based upon the size of openings and pressures used indicated a flow of less than 25 cu ft per hr.

This method of cracking is limited to use on nuts that have space between the kernel and the shell. There must be some space for the gas to occupy before the nut can be exploded. This method of cracking is particularly applicable to English walnuts or nuts of a similar nature.

Explosives Adapted to Drainage Work

By L. F. Livingston

UNDERSTANDING of the use of explosives in drainage work is in general inadequate, and sometimes even inaccurate. For that reason, it is my purpose here to give certain facts which will perhaps clear up the subject and bring it up to date.

In the hands of an engineer, dynamite is primarily a working tool in the same sense as a shovel, a dragline, or a plow. The successful use of explosives, as with any other tool, is determined by the care and expertness of the operator's handling of it, which is, in turn, largely governed by his intimate knowledge of the tool and of its potentialities.

Hardly less important is a recognition of the various types of explosives, the conditions for which each type is best adapted, and the ways in which they can be combined to obtain the greatest economy in operation.

Ditch blasting requires a combination of properties in dynamites different from those usually considered desirable. High velocity and high strength are essential in order that effective blasting execution may result and that the explosive power shall be developed practically instantaneously. An additional desideratum is good water resistance, since water and wet soil are ordinarily in contact with the explosive previous to the shot.

A further essential is that the dynamite shall have a high degree of sensitiveness to propagation of the explosion. This latter requirement holds when the propagation method of ditching is used, which spaces the sticks or fractions of sticks of dynamite 18 to 24 in apart and initiates only the first charge with a blasting cap. The concussion of the explosion of this first stick causes the successive spaced charges to detonate by influence, the explosive wave being propagated through the wet earth.

This last requirement of a high degree of sensitiveness is exactly the opposite of the properties usually sought in high explosives, since insensitiveness to shock has been a characteristic which has directed the trend of dynamites for use in quarrying, mining, and general construction operations, where a separate blasting cap is used for each borehole. Because of the sensitiveness requirements in ditch blasting, the high-strength straight dynamites are the explosives best adapted for the purpose.

A 50 per cent straight dynamite is a favored explosive for use in ditching. The straight dynamites are designated by their nitroglycerin contents; hence 50 per cent straight contains 50 per cent nitroglycerin. The remainder of the explosive ordinarily consists of wood pulp, or other absorbent for the nitroglycerin, sodium nitrate, and a small percentage of an antacid material such as chalk. This dynamite has a velocity of detonation of around 16,000 ft-sec. It possesses excellent water resistance because of the high nitroglycerin content. This explosive would be undesirable for use in confined underground operations, because of the relatively poor quality of its fumes, due to the large amount of wood pulp necessary to absorb the high nitroglycerin content. Ditch blasting is an operation, however, where toxicity of fumes is a minor consideration, since, by the nature of events, it is always carried out in the open. Sensitiveness is the one property which makes the employment of straight dynamites essential in the propagation method for ditch blasting, and 50 per cent straight dynamite is excellent in this respect.

Under some circumstances, the propagation method is not used but, instead, a method in which each hole is initiated by a blasting cap. In such case, the high sensitiveness of the straight dynamite is not necessary and any of equal speed and strength may be substituted in its place. Aside from the sensitiveness, however, the high velocity of the straight dynamite gives it an advantage in this work.

All dynamites sold by the large manufacturers of explosives are tested continually to make certain that the standard formulas and procedures give products of uniformly satisfactory properties. The methods of testing are in general not new, and may well be reviewed briefly.

Strength. The standard method for determining strength in the United States is by means of what is known as the ballistic mortar. The heavy steel mortar is suspended by a frame resting on knife edges. The mortar itself is a cylindrical chamber into which a heavy steel shot fits closely. Ten grams of the explosive under test is fired in the chamber back of the shot, and the swing of the mortar as the result of the recoil from the shot is measured. The exact strength of the explosive is designated in terms of the weight of trinitrotoluene in grams which will give the same swing to the mortar as ten grams of the explosive being tested. A 50 per cent straight dynamite, for example, would have a strength value by this method of about 9.8, which means that ten grams of the ditching dynamite is equal in strength to 9.8 grams of trinitrotoluene.

Velocity. The usual method employed for measuring the velocity of detonation of dynamites is known as the Dautriche method. This determines velocity by comparing the explosive under test with detonating fuse, the velocity of which has been previously determined. The well-known

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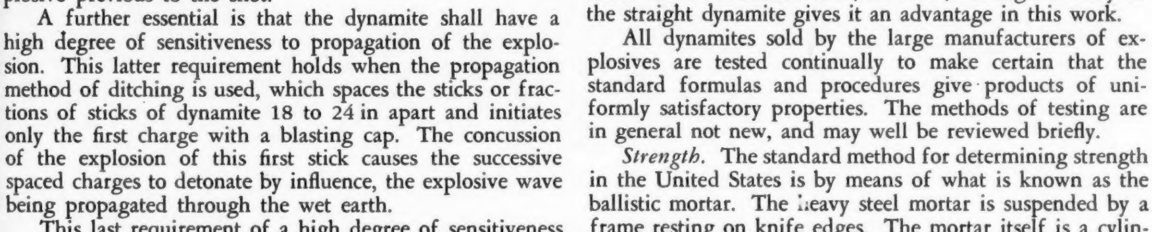
Author: Manager, agricultural extension division, E. I. du Pont de Nemours and Co. Fellow A.S.A.E.



BEFORE, DURING, AND AFTER VIEWS OF A DITCH-CLEANING JOB IN INDIANA, DEMONSTRATING THE USE OF SENSITIVE, HIGH-VELOCITY, WATER-RESISTANT DYNAMITE EXPLODED BY PROPAGATION

Cordeau is the type of detonating fuse employed. It ordinarily has a velocity around 16,000 ft-sec. In determining velocity by this method, a 4-ft length of Cordeau is used, over each end of which a blasting cap has been crimped. The two blasting caps are then inserted into the explosive under test at points 6 in apart. The exact central point of the Cordeau is placed on a fine line across the top of a flat slab of lead and the central portion of the Cordeau lies straight along the top of this lead. At the time of the test, the two inserted blasting caps are exploded successively. The detonation wave travels through the fuse in opposite directions from the two ends, but the wave from the cap first detonated meets the second wave at a place beyond the central point of the fuse. The velocity of the explosive under test can be calculated by simple proportion when the distance has been measured from the point at which the two explosive waves met to the central point marked on the lead. The point of meeting of the explosion waves travelling in opposite directions is recognized by the sharp line made on the surface of the lead.

Water Resistance. Water resistance of dynamites is a relative property and is determined usually by exposing the explosive under test to water under definitely controlled conditions, either at atmospheric or greater than atmospheric pressure. A 50 per cent straight dynamite, for example, can be subjected to a water pressure of 15 lb for 48 hr and still be capable of consistent detonation by a dry primer.

Sensitiveness. The sensitiveness test ordinarily used for dynamites consists in separating two cartridges of an explosive, or two half cartridges, and determining the maximum distance of separation at which the second cartridge is consistently detonated by the first cartridge. In carrying out this test, the separated cartridges are ordinarily wrapped in one long paper tube. The sensitiveness of 50 per cent straight dynamite is such that customarily detonation of the second portion of the explosive will take place when the two are separated by an interval of 40 in.

The proper and efficient dynamite for use in ditch blasting was not arrived at accidentally, but by a careful study of the properties essential to a ditching dynamite. An explosive was then selected which best combined the desirable characteristics.

Economical use of explosives in the building and maintenance of drainage ditches is dependent upon several factors. Of these, one of the most important is the moisture content of the soil. In 1930 to 1936 we experienced a period of extreme dryness in which drainage was neglected. In the first half of last year, rainfall was 12 per cent above normal, and other indications point to the probability that we are now in a cycle of more than normal moisture. This condition will enforce greater attention to drainage needs, and will at the same time facilitate attending to them, using explosives as one of the tools.

Near the end of the dry cycle, it was quite well recognized that 85 per cent of the drainage outlet or open ditches needed cleaning out. Due primarily to the efforts of the drainage division of the U. S. Bureau of Agricultural Engineering and the work of the CCC drainage camps, coupled with the college extension forces, this 85 per cent has probably been reduced to between 65 and 70 per cent.

However, this 65 or 70 per cent still presents a huge task for drainage engineers. It would seem to be primarily a maintenance job, but in many cases the maintenance amounts almost to new construction. I wish to take this opportunity to point out some of the newer developments in the use of explosives in drainage construction.

As I have said, ditching dynamite is made up of 50 per cent nitroglycerin, and the balance is absorbent materials. At the present time, this is one of the most expensive dynamites on the market, due to the high price of glycerin. Hence we have been spending considerable time trying to work out ways and means of lowering the explosive or dynamite cost on ditch blasting work. Heretofore, we have recommended ditching dynamite, only for blasting work where the propagation method through wet soil was used. The studies to which I refer concern the replacing the certain percentage of ditching dynamite with other types of more insensitive, less costly, but equally strong dynamites. For instance, on a posthole job using 20 lb to the hole or load, use 5 lb of ditching dynamite and 15 lb of 40 or 60 per cent ammonia gelatin dynamite. The 25 per cent load of ditching dynamite will carry the shock wave and propagate the other load. The 15 lb of ammonia gelatin dynamite will do the extra lifting and throwing that is required. I referred to 40 or 60 per cent, the choice of either of these depends on the type of soil. If the soil is light, such as muck, 60 per cent should be used. If it is a cleanout job where there is a good hard bottom, the 40 per cent ammonia gelatin dynamite can be used.

Let us take another example, a ditch cleanout job wherein 5 ft of material is to be removed, and ordinarily four sticks of ditching dynamite per hole would be used on 18-in centers. We believe two sticks of ditching dynamite and two of gelatin would produce as good results. The ditching dynamite sticks should be placed on top, because usually the top material is wetter and softer than in the bottom of the hole and, therefore, gives more assurance of 100 per cent propagation. It is possible to use several other types of dynamite in this replacement program. However, we would not recommend any of the ammonia dynamites, because of their inability to remain good in water for a period of time. The straight gelatins could be used for this purpose but these dynamites are not normally carried in magazine stocks throughout the country. A 50 per cent ammonia gelatin might be used, but, again, this is not stocked. However, the 40 and 60 per cent ammonia gelatins are carried in practically every magazine in the country, because they are used in construction and quarry work.

We have not done sufficient work in the many types of soil in the country to give definite, concrete recommendations along this line. For instance, on a four-stick load in a certain type of soil one stick of ditching and three sticks of gelatin may work out satisfactorily. Again, in another type of soil, it may require three sticks of ditching and one stick of gelatin to carry propagation.

In posthole loading, one might get away with 10 per cent of ditching and 90 per cent gelatin, or one might have to use 50 per cent of ditching and 50 per cent of gelatin.

I suggest that if you have to make any estimates or recommendations on drainage cleanout work where the soil is wet, and where the length of the job warrants thorough consideration, that you make several test shots, as it may cut from 10 to 22 per cent from the cost of dynamite.

Another development which I think will interest engineers is the effect of depth on the ability of ditching dynamite to propagate. Our rule of thumb is one stick on 18-in centers. However, in clear water one stick at the surface of water will only propagate 12 in. At 10 ft deep one stick will propagate 10 ft. In other words, the greater the depth in clear water the less the force is lost in the air and the greater will be the propagation.

We have always said that the softer the mud, the nearer the surface the load should be to get the maximum excavation, and this is true, but there is a point at which this does not apply because of failure of propagation. Only experience and test shots will show this point.

Measurement of Soil Hardness

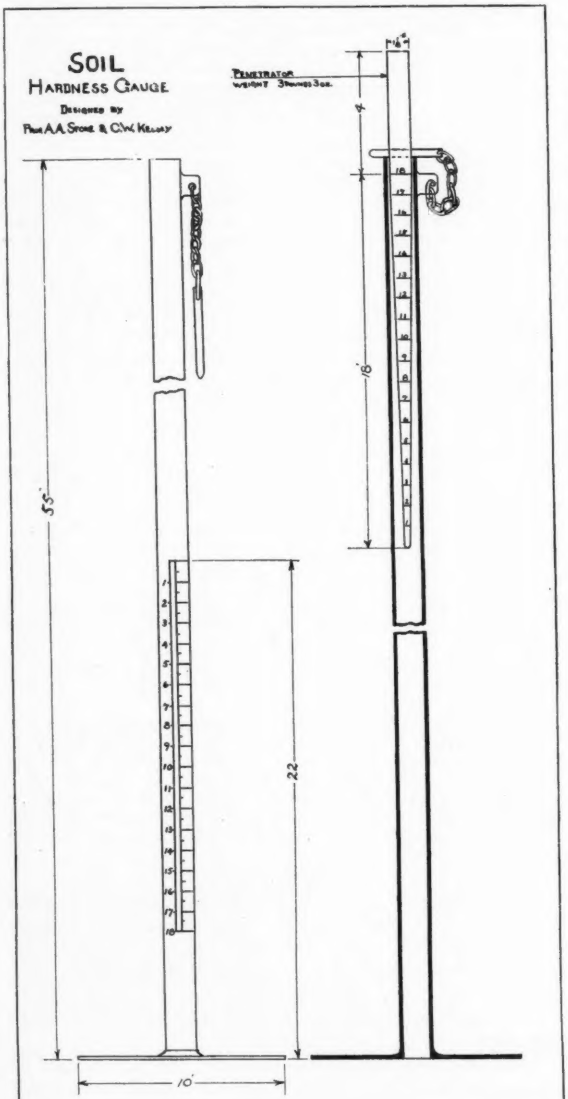
By A. A. Stone and Ira L. Williams

SEVERAL years' work testing garden tractors in various field operations have proved that a vital problem is to find an accurate way to express and define the soil conditions under which such tests are made. It is difficult to state accurately the results obtained without such a basic factor.

Prospective users of garden tractors inquire, "Will it pull an 8-in plow"? Or "Will it plow 7 in deep"? The investigator must then counter with "How hard is your soil"? Or "How difficult are the plowing conditions"? Everyone knows that this factor is subject to extreme variations. Soil resistance tables are, of course, available for various types of soils, based on dynamometer tests. But such figures vary with the moisture content. A sandy soil, in the summer heat, may offer more resistance to the plow than moist prairie sod. Yet in some soil resistance tables, the first is listed as having a resistance of 3 lb to the square inch and the latter 15 lb.

A contribution of the A.S.A.E. Committee on Garden Tractors, 1938.

Authors: Respectively, professor and head of the department of rural engineering (Mem. A.S.A.E.) and instructor in rural engineering, New York State Institute of Applied Agriculture.



We think that an accurate measure of surface soil hardness may be found to be a true indication of resistance to plowing. It may also be found that surface hardness will vary directly with the moisture content.

An accurate measure of surface soil hardness is essential in an attempt to express the power required to operate garden implements such as cultivators, wheel hoes, disks, and seeders.

C. W. Kelsey, a member of the A.S.A.E. Committee of Garden Tractors, has been cooperating with the authors for several years in trying to make a suitable gage or device for measuring surface hardness. The facilities of Mr. Kelsey's factory have made it possible to construct and try a number of different types. The present one indicates our progress thus far, and we believe the idea is sufficiently advanced that it warrants a trial at various places in the United States for the important purposes mentioned and suggested in this paper.

CONSTRUCTION OF SOIL HARDNESS GAGE

The instrument consists of a cylindrical tube or barrel 55 in in height and $1\frac{1}{2}$ in in diameter. This barrel is mounted on a 10-in square plate of 3/16-in steel. The penetrator is a piece of round steel 24-in long, $1\frac{1}{8}$ in in diameter at the top and tapered to $\frac{1}{4}$-in diameter at the tip or lower end, which is rounded. It is divided into 1-in and $\frac{1}{4}$-in graduations.

At the lower end, narrow slots extend upward from the base on opposite sides of the barrel.

A retainer is mounted at the upper end of the barrel, with a pin for suspending the penetrator at a fixed height of 36 in above ground level. The retaining pin is withdrawn manually by the operator when he wishes to drop the penetrator.

The point of the penetrator is hardened to prevent deformation by wear. A long penetrator is needed to make evident slight differences in hardness. Several were tried before this particular shape was adopted.

POSSIBLE USES OF SOIL HARDNESS GAGE

Measurement of soil hardness may be helpful in such studies as the following:

1 Determining the ideal degree of firmness or compactness of the seedbed for various crops. There is no accepted way of expressing this vital factor at present.

2 Measuring and expressing the degree of soil aeration desirable for given conditions, and to aid in determining the results of soil aeration.

3 Expressing accurately the hardness factor in classifying soil types in soil survey work, in prescribing needed tillage operations, to more carefully describe the physical texture of soil, and to supplant indefinite expressions, such as loose, tight, heavy, and light.

4 Measuring the permeability of a soil to water.

5 Determining the physical nature of the subsoil.

6 Comparing capillary action in soils of varying degrees of hardness.

7 Measuring the degree of soil packing caused by tractors and implements and finding definite proof of its results. The question of soil packing by tractors has been discussed much but studied little.

8 Comparing various types of tractor wheels, tracks, lugs, tires, etc., as regards their soil-packing characteristics.

9 Determining the relation between soil hardness and moisture content.

10 Determining the relation between soil hardness and resistance to plowing.

It seems apparent that a device of this nature should have a wide range of use. It may be helpful to agricultural engineers, agronomists, soil research men, and investigators of many problems in agriculture and horticulture. Arrangements have been made for the manufacture of a dozen or more units which will be presented to individuals interested in using them for various purposes to determine their value and suggest improvements and refinements. The present instrument is not perfect. No doubt it can be greatly improved as a result of extensive trials. But it seems logical to state that soil hardness is a vital factor in many agricultural problems. To be able to measure this factor and express the measurement according to a uniform and accepted scale seems highly desirable.

SOIL HARDNESS TESTS MADE AT THE NEW YORK STATE INSTITUTE OF APPLIED AGRICULTURE

Series I — General. The following tests were made in June 1936 under widely different conditions to determine the amount of variation in readings that might be obtained with the 18-in penetrator described above; figures indicate the depths, in inches, reached by the penetrator in the soil being tested:

1 Various locations in cultivated flower beds—6, 6, 5¾, 8, 7, 9¾
2 On dirt road carrying traffic to greenhouse—1¼, ½, ¾, 1, 1¼, ¾
3 On experimental grass plot (sod)—3, 2¾, 2¾
4 In tomato plot, between rows—3, 2½, 3½
5 In alfalfa field, recently mowed—3⅛, 3½, 3
6 In peach orchard, immediately after disking with heavy cutaway disk harrow—9¼, 7¼, 7½
7 In same peach orchard on adjacent, undisked portion—3⅛, 3⅛, 3¾
8 In corn field, corn about knee high—3, 4, 4
9 In field having cover crop of rye, soil classified as clay loam—
(a) At surface 3.5 (average of 65 tests)
(Then one inch of soil removed for each of the following tests:)
(b) At one inch below surface—4¼, 4, 4, 4, 3¾, 3¾, 4¼
(c) At 2 in below surface—4, 4, 4, 4, 3¾, 3¾, 4
(d) At 3 in below surface—3¾, 3⅛, 3¾, 3½, 3½, 3¾, 3⅞
(e) At 4 in below surface—3¾, 3½, 3¾, 3¾, 3½, 3⅜
(f) At 5 in below surface—3¾, 3¾, 3¾, 3¾, 3⅞, 3¾
(g) At 6 in below surface—3⅜, 3½, 3¾, 3¾, 3¾, 3⅜
(h) At 7 in below surface—3, 3¼, 3¼, 3½, 3½, 3¾, 3⅜
(i) At 8 in below surface—3, 3, 3, 3¼, 3, 3⅛, 3⅝

10 Tests on rye stubble field, being plowed on July 17, 1936; rye had been cut on July 10. Three conditions existed in this field, namely, (a) unplowed stubble, (b) freshly plowed land, and (c) land that was plowed and disked one day previous to the tests:
(a) On fresh plowing—7⅞, 9⅜, 8¾, 7⅞, 8½
(b) On plowed and disked land—6¼, 6¾, 6⅜, 4⅜
(c) On unplowed rye stubble—3¾, 2¾, 1⅞, 2⅛, 3¼, 1¾

11 Tests on main service road to Institute campus—1¾, 1⅞, 2, 3¼, 1¼, 2⅜

Series II. Tests to determine relation between soil hardness and draft of plows. Depth of plowing maintained as nearly as possible at 8 in in all cases; a conventional type of two-bottom, 14-in plow with general-purpose moldboard was used, except where otherwise stated:

Station 1—Draft of plow—1205 lb
Draft per square inch of furrow slice—5.35 lb
Penetration on adjacent unplowed land—3¼, 3¼, 3¾
Station 2—Draft of plow—1125 lb, or 5.02 lb per sq in
Penetration on adjacent unplowed land—3¼, 3¼, 3¾
Station 3—Draft of plow—1000 lb, or 4.46+ lb per sq in
Penetration on adjacent unplowed land—4, 4¼, 3¾
Station 4—Draft of plow—1130 lb, or 5.04 lb per sq in
Penetration on adjacent unplowed land—4¼, 3¼, 3⅛, 3, 3¾
Station 5—Draft of plow—950 lb, or 4.24+ lb per sq in
Penetration on adjacent unplowed land—3¾, 3¾, 4, 4¼
Station 6—Draft of plow—1200 lb, or 5.35+ lb per sq in
Penetration on adjacent, unplowed land—3¼, 3, 2½, 2½

Averaging all the tests in this series, it is found that under the conditions then existing, an impression of 3¾ in made by the penetrator indicated a draft of about 5 lb per sq in of furrow slice. To determine whether a definite relation exists between hardness and draft will require many tests under varying conditions.

Series III. Tests to measure aerating effect of plowing. Tests at Stations 1 and 2 below made with a conventional type of two-bottom tractor plow (general-purpose type). Penetration figures in this series all are an average of 10 tests.

Station 1
Penetration on unplowed ground—3.75
Penetration on adjacent fresh plowing—11
Station 2
Penetration on unplowed ground—2.81
Penetration on adjacent fresh plowing—11
Station 3 (Made with Pulverator plow)
Penetration on unplowed ground—3.78
Penetration on adjacent, fresh plowing—10.56
Station 4 (Test on alfalfa sod; made with Pulverator plow)
Penetration on unplowed ground—3.39
Penetration on adjacent, fresh plowing—10.41

Plowing was maintained as nearly as possible at a depth of 8 in in all tests of this series. The softening or aerating effect of the plowing is indicated by the difference in the readings. Averaging the results at the four stations, we may say that before plowing the soil allowed the penetrator to drop into it to a depth of 3.43 in, after plowing it was softened to such a degree that the penetrator entered it to a depth of 10.74 in. The hardness of the soil before plowing could be expressed by the number 3.43, after plowing its hardness would be 10.74. A substance as nearly impervious as rock would, in this scale, be considered zero.

Series IV. Tests of soil packing effect of various types of tractors. Tests were made on fresh plowing. Before the tractors were run over the fresh plowing, an average of eight tests gave a penetrator reading of 10.56 in or the hardness of the fresh plowing was 10.56 for stations 1, 2, and 3. The tractors were then run over this fresh plowing and readings taken in the tread marks.

Station 1—Wheel tractor with pneumatic tires—wt 3300 lb
Penetration in wheel marks—4.034 (average of 7 tests)
Station 2—Track-type tractor—wt 6600 lb
Penetration in tread marks—4.552 (average of 7 tests)
Station 3—General-purpose tractor with 8-in steel rims and 4-in spade lugs—wt 4300 lb
Penetration in wheel marks—5.45 (average of 7 tests)
Station 4—General-purpose tractor with skeleton wheels and overhanging spade lugs (4¾-in high x 3½ in face) wt 4020 lb
Penetration on fresh plowing—6.75
Penetration in wheel marks—5.50

These tests, of course, are not sufficient to determine the relative soil packing effect of different types of tractor treads. It would be unfair to make direct comparisons of tractors differing so widely in weight. The tests are presented to indicate how a soil hardness gage could be used in making a study of this nature. Its use should also be of material benefit to designers of tractor treads and lugs, no matter with what particular type they are concerned.

CONCLUSIONS

Soil hardness is a factor that affects many agricultural and horticultural problems. The development of a uniform method for measuring soil hardness and a uniform scale of numbers for expressing it seems highly desirable. The existence of such a method and scale would make possible the intelligent comparison of results secured and conditions met with in various sections.

The instrument described here and the method for its use are presented as a starting point for work toward this desirable objective.

Prefabricated All-Steel Units for Low-Cost Buildings

By Ray Crow

THAT THE low-cost house of the future will be a factory-built package unit complete in all details, sold erected or ready to erect with a minimum of field labor, is considered by many authorities to be a foregone conclusion. The most effective argument to this end is contained in a report issued by the Federal Commission to Investigate Economic Waste some years ago, to the effect that under the conventional system of residential building construction there is a waste of 53 per cent. It is evident that in the elimination or partial elimination of this item there lies an opportunity for the profitable application of factory methods whereby costs of construction can be radically reduced. However, it will take years of intensive effort to overcome the serious handicaps now involved in developing a type of building that the public will buy as homes on the same basis that it now purchases motor cars.

Such a structure must be developed by a process of evolution, and when finally produced it may bear no closer resemblance to the conventional house of today than does the modern motor car to the horse-drawn phaeton of thirty years ago. What the material may be, how the rooms will be arranged, to what extent accessories such as bathroom and light fixtures, kitchen equipment, and other items that are now assembled as separate units, will become integral parts of the structure itself, all remain to be seen. It is not difficult to visualize, for instance, a bathroom with walls, floor and all fixtures stamped or molded as an integral unit from a material possibly not yet developed, in a single factory operation with fittings attached, all ready for installation, at a fraction of the cost of assembly under present conditions.

Through a coordination of the efforts of the engineering personnel of the construction division of the Farm Security Administration with those of the technical staff of the Tennessee Coal, Iron & Railroad Company, under the supervision of the author, there resulted a design in copper-bearing sheet steel. In developing this the following assumptions were made, based on previous surveys of the housing field:

1 The factory-built house, as a complete package unit, has not yet been developed in a practical way, except in the form of automobile trailers.

2 Factory methods could be applied efficiently to the assembly of basic material into units larger than those customarily used, from which structures of various floor plans, and designed for divers uses, could be erected with a minimum of field labor.

3 The units should be so designed that they could be readily fabricated locally without excessive outlay for manufacturing equipment. This to reduce the cost of local distribution of the finished product.

4 The units should be of such size and weight as to be readily handled by man power and put together simply without unusual equipment, with labor available in rural, as well as urban, areas. Also, in connection with light weight, they should pack readily for shipping.

5 The same type of unit should be applicable to the erection of various classes of buildings with equal facility, thus lending itself to a wide range of varying requirements.

6 The unit should be so designed and connected that the structure could be remodeled, or dismantled, moved, and rebuilt with the maximum salvage value.

7 The units should provide for accessories in such a way as to eliminate later cutting and fitting, even though accessories are not installed at the time of original erection.

8 Permanent protection from weather should be incorporated in the fabrication of the units as far as possible so that the final finish to be applied in the field, as well as for maintenance, should require a minimum of expense.

9 Fabrication of units should apply only to the framing, covering, and siding of the structure, but provision made for ready attachment in the field of all necessary inside finish, such as insulation, trim, et cetera, in order that a wide variety of conditions could be met.

10 While the general design was developed looking toward the rural market in the Southeast where the application of the Bankhead-Jones act would be proportionately heavier, the necessity of low-cost housing in urban districts there and elsewhere was not overlooked. By increasing insulation and heating facilities, it should be possible to

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Author: Engineer, sales promotion division, Tennessee Coal, Iron, and Railroad Co. Mem. A.S.A.E.

(LEFT) SMALL BARN WITH HAYLOFT ASSEMBLED FROM PREFABRICATED STEEL UNITS. (CENTER) COMBINATION SMALL BARN AND POULTRY HOUSE WITH LIMITED LOFT SPACE. (RIGHT) POULTRY HOUSE OF PREFABRICATED STEEL FOR 50 BIRDS

meet the demands of the rigorous winter climate of the North, and by rearrangement of the interior, provision should be possible for the different living conditions of urban dwellers.

On the basis of these assumptions, studies were made of the inherent possibilities of the various available materials, either singly or in combination, and, as indicated above, the result was to attempt the design in copper-bearing steel. One potent influence to this end was the fact that light-weight galvanized steel sheets have been used for roofing and siding materials on low-cost buildings, both commercial and residential, sufficiently long to prove their value for this purpose. Other factors favorable to the use of steel as a covering and framing material may be summarized as follows:

1 Steel is unshrinkable, changing but little from variations in temperature, and none from the effects of moisture.

2 When properly proportioned and used, steel has greater strength and rigidity for the area and weight of section than commonly used material, therefore it may be produced and fabricated at a comparatively low cost.

3 Steel is nonporous, therefore, wind and moisture-proof no matter how thin.

4 Steel can be manufactured in large sections, thereby reducing the joint lengths through which water and air may filter.

5 Under modern conditions of manufacture steel is practically uniform in strength, therefore requires only a small factor of safety in design.

6 Steel lends itself to machine forming with low applied labor costs, therefore is economical where parts are fabricated and assembled in quantity.

7 When kept dry, either by location or by coating with moisture-proof material, steel will last almost indefinitely.

8 In a factory operation there is only a small loss of steel because of the wide variety of sizes, shapes and thicknesses from which to choose the desired items. Such scrap as develops has a definite market value.

9 Steel is non-combustible; it is vermin and insect proof and presents a surface easily kept clean and sanitary.

10 The weight per square foot of wall or roof area fabricated from steel material is lighter than that from other material.

On the other hand, the following factors that militate against the use of steel as a building material were taken into consideration:

1 It is a better conductor of heat than certain other building materials, therefore, it requires somewhat more insulation under certain conditions.

2 It does not lend itself to hand-forming or shaping in the field, except when used in the form of thin sheets; therefore, it is not adaptable to general field use, except in precut or prefabricated units.

3 For light loads and long spans, if the metal is so distributed as to prevent excessive deflection when the extreme fibres are stressed to safe working limits, the webs and flanges of joists, rafters, and other sections used as beams are so thin as to be easily distorted by shipping and handling.

4 In the presence of moisture and oxygen unprotected steel is subject to corrosion and under certain conditions will deteriorate rapidly. However, protective coatings have been developed to the point where, with a little care in their use, the steel even in thin sheets, will last almost indefinitely. Also, it has been determined that a small percentage of copper adds materially to the life span of the product.

From the results of a study of the dimensions of residences and service buildings that have been developed by various federal agencies, the housing divisions of agricultural colleges, and independent architects throughout the country, it was evident that outside wall lengths were largely multiples of 4 ft with an occasional unit of one-half that width. This is probably accounted for by the fact that standard framing lumber lengths are in even feet, and two runs of this unit give a multiple of 4 ft. Standard steel roofing and siding sheets are 2 ft wide; two of them therefore would cover a 4-ft panel, and one a half panel. Also, 4 ft is a convenient width in which to frame an outside door or window opening. It was decided, therefore, to standardize on a 4-ft width panel or module, for floors, ceilings, roofs, and outside walls of all structures with such lengths as were needed, but to provide for the making of half-panels for use when desirable.

TYPICAL FARM RESIDENCE IN PREFABRICATED STEEL, ADAPTABLE TO A VARIETY OF FLOOR PLANS

Since partitions are designed as non-bearing and the covering is attached in the field, there is no necessity to restrict the inside room dimensions to any particular multiple. Partition frames are made in widths of 2, 3 and 4 ft as individual units, together with a percentage of adjustable width frames to allow for filling in special spaces where needed. This provides complete flexibility in arranging dimensions of rooms, closets and hallways, not only in initial construction but also for rearrangement at any time at a small cost, without in any way affecting the exterior shell.

The design of individual frame members was a matter of applying engineering principles modified by practical consideration. Theoretically, the weights of the sections could be reduced materially by using deeper webs and thinner gages. Practically, however, ultrathin webs and flanges would present so many hazards in the way of being distorted by handling and shipping, that their use is impractical for framing purposes. Many city building codes set a minimum thickness of 14-gage base metal to be used in cold formed sheet metal joists. It was therefore decided to form the side members of the panels from 14-gage metal with webs 2⅜ in deep and flanges 1⅛ in wide. The cross members or belt courses of the frames are formed sufficiently narrower to provide a slip-fit into the side member channels to be welded rigidly in place.

The roof and ceiling panels of all structures are the same as for outside walls except in length. This dimension, of course, varies with the span of the roof, but by standardizing on a specific pitch it is necessary to provide individual lengths only for each 4-ft variation in width of building. This also simplifies construction of gable panels,

as they can be made interchangeable for all buildings. The two sides of the roof with the corresponding ceiling panel are formed into a triangular Pratt truss, assembled in the field, with struts and diagonals connected to gusset plates by means of bolts. This roof system does not lend itself readily to hip and valley construction, although such can be provided at a somewhat greater expense. So far no real demand for it has developed. By the use of beaded steel sheet ceiling welded to the lower side of the ceiling panels, and insulating above with mineral wool, either loose or in bats, there is no combustible material above the ceiling line. Sheet steel stove flues and chimneys are attached directly to the roof structure with no attendant danger of fire. If desired, fiber board or other surfacing attached directly to the ceiling frames may be used in lieu of the overhead sheet steel ceiling.

The outside wall and roof covering of all structures is standard galvanized steel sheeting, a material that has proved itself as being excellent for the purpose throughout the country, and particularly in the South, for many years. It is attached to the frames in the shop by means of spot-welding at frequent intervals, thus eliminating nails, rivets or bolts with their attendant holes through which moisture may seep. Steel sheets become an integral part of the frame structure, adding materially to its strength, rigidity, and obviating any necessity of diagonal wind-bracing in the walls.

Floors of practically any type can be used. For residences several designs have been made, all supported by standard steel joists which consist of two 14-gage cold-formed channels with 6-in webs and 2-in flanges, welded back to back. The joists span the full length of the building are connected at the panel points, or 4-ft on centers, and supported as often as necessary to carry live and dead loads.

At first, standard conventional masonry foundations were considered as a matter of course and these are yet optional with the buyer. The steel frames may be readily bolted down to any type of brick or concrete wall, but to obtain uniform bearings, the top of the latter must be finished much more accurately to line and grade than is the case with most conventional construction. The steel frames are assembled in precision jigs or master frames, and when bolted rigidly together form a structure without sag or warp in any part. When erected the building will be square, rigid, and in a plane.

Insulation is of prime importance in any structure where control of wide variations in temperature is necessary. The most important problem presented by this phase of building construction has not yet been solved, that is, the production of a low-cost and efficient moisture-proof material easy to apply; that is not subject to expansion and contraction with variations of temperature; that will add structural strength to the building and at the same time offer a surface that lends itself readily to decorative finish. Practically any of the materials offered to the public have some of these characteristics. Since it is desirable to ventilate the steel frames in the structures under consideration to prevent condensation, a fill type of insulation is not desirable.

Protection of the metal is provided by (1) using galvanized sheets for all exposed surfaces, (2) spraying an additional coat of zinc dust zinc oxide metal primer over all surfaces of the unit, both galvanized and black, after fabrication, and baking this dry in an oven, or if time permits allowing it to air-dry thoroughly; (3) dipping in emulsified asphalt all parts that come in contact with or are placed near the ground; (4) during erection all scratches and breaks are retouched with the same material originally applied; and (5) after erection all outside surfaces are given one or more coats of good outside paint as a finish.

Windows and doors are framed into the standard width panels in the shop, and such panels come to the job ready to bolt in place just as do the plain wall units. The purchaser has the choice of either standard steel casement or steel double-hung sash, the latter slightly higher in cost. In either case the sash frames may be welded in place in the shop or may be installed on the job by the use of screws and bolts. In the former case it is recommended that glazing be done in the field, in the latter glazing may be done at the factory and the complete window inserted. In all cases wood jambs are installed in the shop and the only carpenter work necessary is to apply the inside casings, stool, and apron, after the insulation board is put in place. Doors may be either wood or steel and are easily hung and trimmed in the field in the accurately framed openings provided in the shop. Base board may be either wood or metal.

Certain limitations have been recognized as regard height and size of structures, as well as arrangement of floor plan. No attempt has been made to fabricate multiple-story units other than for the erection of a hay-loft type of barn with an eave height of 12 ft. A standard 4-ft wall or roof panel weighs approximately 8 lb per linear foot; therefore one 18 ft long would weigh 144 lb, which approaches the maximum that can readily be handled by man power for erection. This limits the convenient width of the building to 32 ft or 8 panels. In general, floor and ceiling panels for structures wider than 20 ft are made in two sections and spliced in the field. A hip and valley type of roof including dormer window construction is more expensive than straight gables.

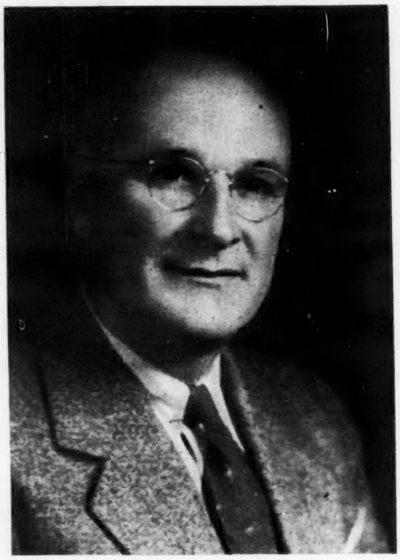
It is desired to emphasize the fact that this design does not cover prefabricated or factory constructed buildings as such, but is a system whereby basic structural material is prefabricated into larger than customary building material units from which the frame and outside covering of various types of buildings may be erected with a minimum amount of field labor. Except in the matter of length and possibly type of covering, these prefabricated panels are similar whether the structure be a residence, garage, barn, smokehouse, poultry house, cotton house, shop, tourist or beach cottage, bath or boathouse. The difference in completed structures lies in floor dimensions, number and type of openings, and inside arrangement, including type and class of finish and accessories.

The shop welding in precision jigs of all parts of the frame panel and outside covering materials, produces a strong rigid unit with no exposed connections to be affected by expansion and contraction, and insures accurate fitting of all parts for erection. When these prefabricated panels are bolted together in the field in accordance with the erection diagrams and instructions, the resulting buildings are strong and rigid; weather, fire, and vermin resistant; have low maintenance and depreciation costs; can be erected in a fraction of the time required for conventional construction; may be dismantled, moved, and reerected including even the foundation, either partially or completely, at a small cost, with practically 100 per cent salvage value; and when all factors are considered, the initial cost is but little out of line with that of a fair quality of low-cost conventional construction.

It is not thought for a moment that this system of construction is the final answer to the low-cost housing problem. However, the results so far obtained have fulfilled expectations and it is felt that a distinct advance has been made in a development that heretofore has been left largely undirected—that of providing permanent, livable and usable structures for farmers, and for industrial workers in the low wage brackets, at prices they can afford to pay.

H. B. Walker to Be 1939 Deere Medalist

IN THE selection of Harry Bruce Walker to receive the 1939 award of the John Deere Medal, the Jury of Awards of the American Society of Agricultural Engineers evidently has again made summation of service its main criterion. Seldom, if ever, has the Society designated for either of its medals a man whose achievements have been so broadly balanced among all the major branches of agricultural engineering. Despite this division of emphasis, Professor Walker has abundantly earned the distinction which the John Deere Medal aims to recognize—the "application of science and art to the soil."



HARRY BRUCE WALKER

Nor is any candidate for the honor likely to spring more surely, to be more firmly rooted in the soil. His father and mother before him were of farm parentage, and it was on a farm near Macomb, McDonough County, Illinois, that he was born. All of his primary education was in the rural schools of the county, and never, in a strict sense, did he have the advantages of high school. Not until he was nineteen did he have any secondary training. Then he entered a private preparatory school at Macomb, sustaining himself by "working his way." Meanwhile he had been working as farm hand at home and on other farms, his wage at one time being thirteen dollars a month and board.

About a year after he entered the school at Macomb, it closed. After an interruption of another year he resumed his studies at Highland Park College at Des Moines, Iowa. Soon he visited Iowa State College at Ames, nearby, and resolved that with its facilities he would become a civil engineer. As yet, however, he had not completed the equivalent of high school. But at that time Ames offered subfreshman work, and early in 1906 Mr. Walker entered as a special student, washing windows and scrubbing floors for fifteen cents an hour in a vain attempt to make ends meet.

After a semester he was forced to seek full-time employment, but he had begun to be an engineer. For seven months he served as topographer for the Burlington Railroad. Returning to Ames again for the second semester he found work in the instrument room and as a student assistant. In four years he made up his high school deficiencies and was graduated with the class of 1910 as a bachelor of civil engineering.

During two summers he did drainage engineering in Humboldt County, Iowa, and on graduation worked a short time for the Great Northern Railroad, in North Dakota. Soon, however, he entered the service of the state of Kansas where, in many capacities, he was to spend seventeen of his most productive years. This period was interrupted when, at the entry of the United States into the World War, Mr. Walker joined the army and served as captain in the Engineer Corps and as assistant 78th Division engineer, A.E.F. As such he took an active part in the St. Mihiel and Meuse-Argonne offensives.

From 1910 to 1920 he served the Kansas State College extension service as drainage and irrigation engineer, state irrigation engineer, and extension engineer. For three years he was associate professor of civil engineering. For two periods he was engineer for the Kansas Water Commission, and later was for five years a member of the Commission. He was for a time special consulting engineer for the Garden City (Kansas) project of the U. S. Reclamation Service, and for two years consulting engineer of the Kansas State Fish, Game and Forestry Commission. For two years he was a member of the city planning commission of Manhattan, and for four years supervisor of the Kansas Committee on the Relation of Electricity to Agriculture.

In 1921 he became head of the department of agricultural engineering and agricultural engineer of the allied experiment station. In 1927 he was granted a year's leave of absence to serve as senior agricultural engineer in the U. S. Department of Agriculture, carrying on to completion the survey of research in mechanical farm equipment handled similarly the preceding year by Dr. J. B. Davidson. It is said that this study did more "to correlate and extend research in the field of farm power and machinery throughout the experiment stations of the country than any other similar work in the history of the profession."

He had been back at Kansas State only a few months when he resigned to become chairman of the division of agricultural engineering at the University of California, and agricultural engineer in the California agricultural experiment station. He also is chairman of the California Committee on the Relation of Electricity to Agriculture, a member of the faculty clubs of Davis and Berkeley, of the Pacific Coast Electrical Association, and of the San Francisco Tractor and Implement Club.

Called upon to name but a few among his myriad achievements, his associates mentioned the farm building plan service developed under his direction at Kansas, and the similar service now at California; his investigation of farm sewage characteristics and behavior which brought order out of chaos in the design of systems for its treatment and disposal; a later but somewhat similar study of dairy barn wastes and their disposal; studies in the harvesting and storage of grain sorghums, rice, wheat, etc.; and farm fencing investigations. More recently he has directed research and development involving cotton harvesting machinery, sugar beet machinery, orchard heating, walnut dehydrators, insect control by dusting and burning, bean harvesters, fruit washers, and asparagus machinery.

In 1929 Professor Walker was appointed by the President of the United States as the national delegate for agricultural engineering at the World Engineering Congress in Tokio, Japan, and presented there a noteworthy paper.

Now a Fellow in the American Society of Agricultural Engineers, he was first vice-president—and acting president —in 1924-25, and at the (Continued on page 32)

P. S. Rose to Be 1939 McCormick Medalist

SIXTY years of applying power in agriculture is part of the story behind the election of Philip Sheridan Rose as the donee of the Cyrus Hall McCormick Medal for 1939. At first it was the power of his own almost infantile muscles, for he cannot remember the time when he first wielded the axe as he helped his pioneer family to hew home and farm from the woods. At the age of eight he took hold of the handle at the end of the cross-cut saw. At fourteen he was an experienced ox teamster, a skilled loader and log skidder.

PHILIP SHERIDAN ROSE

Born in 1872 at Allendale Center, Ottawa County, Michigan, Mr. Rose was the son of a Scotch father and an Irish mother. Their families had come from Aberdeen and from Dublin to Canada about the middle of the century, and thence into Michigan shortly after the Civil War. His first home was near Grand Rapids, so close that a round trip to town took only twenty-two hours by the predominating type of transportation, not only in the countryside but on the streets of the city—ox team. The distance was fifteen miles.

But when Phil was seven his father traded that forty-acre farm for a larger place in the Manistee River country where the big lumber companies and their French-Canadian-Indian log rollers were stripping the land of its virgin pine. In his early teens Phil took his place as a man, rising at four in the winter mornings for a couple of hours at farm chores before breakfast, and getting into the woods ahead of the dawn. After helping to cut and skid a load of logs he was free to walk to school, usually pretty well soaked from the snow in which he had been working.

In all he attended the rural schools, sketchy as they were, for forty-two months. Of high school he had twelve weeks. And this was the man who was to take his place with outstanding educators from a dozen colleges and universities at the momentous meeting which founded the American Society of Agricultural Engineers, and in 1910 to be its third president. Yet, far from feeling handicapped by his lack of high schooling, Mr. Rose regarded it as having saved him a lot of wasted time.

To be sure, there was some quibbling about admission requirements when, a term late, he entered Michigan Agricultural College at East Lansing in 1893. He never had any trouble in mastering college work, and in the two remaining terms of that year cleared up all deficiencies for admission as a regular student. Of course, he was always a student, with special interest in history and the sciences, regardless of schools. He also was a country school teacher for several terms to earn funds for college expense.

Interrupted by illnesses in the family, including the passing of his mother, his college course in mechanical engineering was completed in 1899. Without waiting for graduation time, he went to work as a draftsman and was on his way to become a machine tool designer when the fate that shapes men's lives took a hand. He agreed to complete a year's work for a friend who resigned from the staff of North Dakota Agricultural College to accept an opportunity with an eastern firm. So Rose went to North Dakota for seven months and stayed ten years.

Those were the halcyon days of virgin sod, breaking plows, wheat and more wheat, big threshers, straw-burning steam engines, and grisly boiler explosions. So Phil, who had come to teach mathematics and engineering, was directed by legislative enactment to show young Dakotans how to run steam engines without blowing them up. He found it interesting work, and he loved it. In the ten years he trained seven thousand men and, so far as known, not one ever had a serious accident.

Though his courses never attained the scope of agricultural engineering as we know it today, Rose made pioneer strides in that direction. He continued to teach thermodynamics and the mechanics of engineering while expanding the agricultural courses to include all the threshing and power farm machinery of the time. One summer vacation he devoted to a promising connection with the General Electric Company at Schenectady; some of the others he sold threshing machinery in North Dakota. Then, to meet the great demand for instruction in threshing machinery, he conducted his own private one-month schools of practical farm engineering in Minneapolis and later in Fargo.

While running these thresher short-courses he made the acquaintance of Bascom B. Clarke, picturesque personality and head of the Clarke Publishing Company. Rose was thinking that it was time to quit teaching; Clarke was launching a new magazine, "Gas Review." So Phil went to Madison, Wisconsin, and presently took over the editing not only of the new publication but also of the older "American Thresherman," long loved by custom operators of heavy farm machinery.

That was in 1909, just the threshold of the power-farming era. Ahead were the fateful years which were to witness the decline of steam and the rise to dominance of internal-combustion power on the farm, also the transition from custom threshing to individual or group ownership of the so-called heavy farm machinery. New readers needed semitechnical instruction in a new power, and wise counsel in its economic adaptation. There were perplexing problems of publishing policy. Thus did Rose devote eight challenging, happy years.

Then, in 1917, came a call to join the Curtis Publishing Company as agricultural engineering editor of "Country Gentleman." He had the vision to know that the boom days of the tractor industry were numbered, and that a deeper revolution in farm practice and farm life was at hand. For another eight years he roamed America in research into its farm life and the place of agricultural evolution in the national scene. He wrote feature articles, sometimes thirty-six in a single year, not to mention editorials, and also studied stacks of manuscripts offered by

other writers. Then, in his own words:

"In 1925, as a result of one of those reorganizations that afflict American business, I was taken off the road and made a managing editor. Two years later came another shift and I found myself seated in the editor's chair. I have now been editor of "Country Gentleman" eleven years. They have been very exciting years, very interesting years, and very troubled years. But I am glad of the opportunity they have given me.

"I have had a chance to carry out a great many ideas I had wanted to try for a long time. They gave me a chance to take an active part in the new and exciting science of agriculture that is developing in America. They have given me a chance to use and to present my engineering knowledge and experience from a new and different angle. I feel that today "Country Gentleman" is doing more for the new agricultural engineering than it ever was able to do for the old."

To enumerate the writings of Philip S. Rose would be like undertaking to number the stars. Let a few early examples suffice. His first contribution to technical literature was in 1906, when Dr. Liberty Hyde Bailey asked him to prepare a chapter on farm power for the "Encyclopedia of Agriculture." The next year he wrote for the Clarke Publishing Company a correspondence course in traction engineering—the same year that he became a founder and charter member of the A.S.A.E.

In 1915 or thereabouts he officially represented the young Society at a meeting of the International Association of Engineers in San Francisco. In his paper on agricultural power he presented the first survey ever made of the amount of power used in American agriculture. It was widely republished both in this country and abroad. Eighteen months of checking by the far-flung facilities of one of the world's great farm machinery companies verified the substantial accuracy of his figures.

As early as 1914 he predicted that tractors would release from thirty to forty million acres of land then required to support draft animals. He was an early protagonist of the small, general-purpose tractor. From 1930 onward Mr. Rose has campaigned for soil erosion control both by strictly engineering methods and by vegetation. For the latter purpose he advocated lespedeza when there was not a single acre of it in America, and has seen it adopted to the tune of fifty million acres. Through his publication he also has worked for a greater use of grass in American farming, and played a leading role in the creation of twelve grass breeding stations.

Space will not permit, nor is this properly the place, to tell of his successful leadership in such matters as fertilizer research and improvement, game and fish conservation, the Jones-Bankhead act, non-arsenical insecticides, plant genetics, plant hormones and colchicine, public health and the control of several of its scourges. Nor can we make more than passing mention of the contributions which, though outside his own special field, he has fostered in the realm of rural housing.

All, however, have their proper place in the "unity of life" which he has been advocating as the basis for scientific research in agriculture, and which is the guiding principle of his own purposes and practice. To them all he has brought the engineering approach, the engineer's habit of mind. They all bulwark the myriad achievements of more strictly engineering content which have marked his pathway along sixty years with farm power. All, presumably, played their part in the summation whereby the jury determined to designate him as the eighth recipient of the Cyrus Hall McCormick Gold Medal.

H. B. Walker to Be 1939 Deere Medalist

(Continued from page 30)

same time served as the Society's representative on American Engineering Council, also on the administrative board of the Council. He is a past-president of the Kansas Engineering Society, a member of the American Society of Civil Engineers and of the Society for the Promotion of Engineering Education, and a fellow in the American Association for the Advancement of Science. His memberships in honorary Greek-letter societies include Tau Beta Pi, Sigma Tau, Sigma Xi, Phi Kappa Phi, and Gamma Sigma Delta.

A bibliography (probably not exhaustive) shows forty-five items headed "Walker, H. B." They begin in 1912 with drainage papers published by the Kansas state extension service and by the Kansas Engineering Society. Within a year from his affiliation with the American Society of Agricultural Engineers in 1921 he had a pretentious paper in its Transactions. From then on with increasing frequency his name appears both in the Transactions and in AGRICULTURAL ENGINEERING. He has contributed chapters to textbooks and articles to farm papers, educational journals, sundry engineering journals, and publications of electrical, building, and farm machinery trades.

Professor Walker's family consists of his wife, Coralie Harris, whom he married in 1912 at Bardolph, Illinois; a daughter, Mary Margaret, now a graduate student at the University of California; and a son, Boyd Wallace, an undergraduate student at the University of Michigan. In his home community at Davis, California, he has served as trustee both for the high school and for the Community Church. He serves on the agricultural committee of the Sacramento Chamber of Commerce. From the humblest of home responsibilities to the highest national and international honors his profession has to offer, he has consistently shown the soundness of his citizenship along with the amazing comprehensive scope of his talent. Modest in manner almost to reticence, he yet is known throughout the profession with the sort of esteem which makes every man glad that his friend Harry Walker, is to be honored by the award of the John Deere Gold Medal at the next annual meeting of the American Society of Agricultural Engineers in June of this year.

Process of Progress

EDUCATION, discussion, examination of experience disclosed in the past, and examination of present abuses and their causes, all brought impartially into the comprehension of all people of a nation, comprise the one hopeful process in the aid of progress. It is an inherently slow process which cannot be overhastened with safety. Any effort to press forward beyond a point acceptable to the intelligence of the people is a false effort because it carries with it the germs of harm. Such effort is hurtful to the best aspects of the mutual relations on which civilization depends, and ultimately is a retardant of both engineering and civilization, which we need to carry forward coordinately with each other if we are to progress soundly.—From "Engineering's Part in the Development of Civilization," by D. C. Jackson, Mechanical Engineering, December 1938.

What Agricultural Engineers Are Doing

Contributions Invited

All public service agencies (federal and state) dealing with agricultural engineering research and extension, are invited to contribute information on new developments in the field for publication under the above heading. It is desired that this feature shall give, from month to month, a concise yet complete picture of what agricultural engineers in the various public institutions are doing to advance this branch of applied science.—EDITOR.

FROM THE U. S. BUREAU OF AGRICULTURAL ENGINEERING

THE engineering staff of the Cotton Ginning Laboratories, Stoneville, Miss., is receiving inquiries on engineering problems and new gin installations. An unprecedented number of gin fires throughout the cotton belt have paved the way for the construction of new ginneries modernized along the lines recommended by the Laboratories.

A 40x112-ft steel building for further cotton ginning research is now under construction at Stoneville, funds coming from PWA and WPA allotments. The three-story office and fiber laboratories building, unfinished in parts for several years, is receiving final plastering. A new physics laboratory is taking form there. W. H. Kliever, working under Chas. A. Bennett, will be in charge of it.

* * *

Compress cuts of cotton bales has been the subject of a preliminary study by W. H. Kliever of this Bureau and Chas. S. Shaw of the Bureau of Agricultural Economics. Three hundred sixty bales were observed for number and severity of cuts, weight, density of compression, speed of compression, and moisture, grade and staple of the cotton.

* * *

Cotton gin fat tests are progressing favorably at the laboratories. Air tests and cotton handling tests by V. L. Stedronsky and T. L. Baggette measure efficiencies and capacities of various types now on the market and of many new designs. The higher efficiencies shown to be possible will be of much interest to the cotton industry.

* * *

Lewis A. Jones spent the week of November 28 at Chicago attending a meeting of the CCC district engineers and inspectors in connection with the general supervision of the work. The planning of the work was reviewed and a detailed outline prepared. Representatives of the SCS attended the meeting and outlined the procedure under which the drainage camps will be absorbed by the Soil Conservation Service after January 2, 1939.

* * *

John G. Sutton has prepared a series of drainage curves for use in determining runoff coefficient in the middle western states.

* * *

The CCC drainage camps report the following work accomplished in November: 4,637,758 sq yd of clearing; 1,684,330 cu yd of excavation and embankment; 31,993 lin ft of tile reconditioning and 15,687 man-days on structural and miscellaneous maintenance work, using a total of 110,936 man-days.

* * *

As a continuation of his work as engineering advisor of the International Boundary Commission, Fred C. Scobey made a study of the hydrometry work on the Rio Grande from El Paso to the mouth of the river below Brownsville, Texas. Also, as a member of an engineering board, he made a study of the rectification of Rio Grande from El Paso to Quitman Canyon, which had shortened the river from 155 miles to 88 miles in the reach mentioned. The purpose of this rectification was to increase the gradient of the stream so that sand will not be deposited at low water and raise the river bed. Because of such deposits small floods originating below Elephant Butte Reservoir create more hazard than existed before the construction of that reservoir. This rectification has been effective in reducing the general level of the river bed. The purpose of the November meeting of the engineering board was to decide upon the location and type of drops to install, so that floods of 5,000 to 10,000 sec-ft will not concentrate in the Pilot Channel but will flow in the whole prism provided between set-back levees.

* * *

J. C. Marr completed the manuscript for a bulletin on "Principles and Practice of Snow Surveying." Studies were made by Messrs. Marr and Jessup of correlation of snow measurements with runoff in the various drainage basins where observations of snow cover have been made. R. A. Work reviewed snow course sketches and brought them up to date by adding required changes or corrections as determined last summer. He also established satisfactory short wave radio communication between Medford, Ore., and Lassen Volcanic National Park, Calif. A conference of cooperators in the snow survey project was called by Paul A. Ewing at Redding, Calif., on November 3, at which time plans were discussed for the winter sports broadcasts for the coming winter season. R. L. Parshall called a conference of snow survey cooperators in Denver on November 22, where representatives of the Forest Service, Weather Bureau, Bureau of Reclamation, State Engineer's office, National Park Service, and our Bureau were present. Arrangements for handling this coming season's snow survey work in Colorado and Wyoming were discussed in detail. Plans were made to provide a winter sports program starting December 16, and ending about April 1, to be broadcast over Station KOA Denver, each Friday afternoon.

* * *

Paul A. Ewing completed the field work on the agricultural survey of San Fernando Valley, Calif., and is now preparing the report of this study. Dean W. Bloodgood and Homer J. Stockwell continued tabulation of data secured from the Van Nuys office of the Los Angeles Water Department on use of water for various crops in the Valley for the past 6 yr. Mr. Bloodgood prepared an enlargement of a soil map showing soil classification of the soils of the Valley, bringing up to date the information presented and also indicating areas that might be used for future soil moisture investigations.

* * *

Carl Rohwer reports that work on that part of the dam and spillway for the Southern Great Plains Station of the Bureau of Plant Industry, at Woodward, Okla., included in the original contract was completed by the contractor on November 10. During the five months the dam has been under construction, Mr. Rohwer has acted as the representative of the Government to oversee the work, and has personally supervised some phases of construction. Mr. Rohwer has returned to Fort Collins.

* * *

Tests of the sand trap model conducted at the Bellvue laboratory at Fort Collins, Colo., by R. L. Parshall indicate as high as 90 per cent efficiency under certain conditions of flow. Sufficient knowledge of this device has now been obtained to warrant the proposal of the design for the full-sized structure for the New York Canal of the Boise irrigation project.

* * *

Dean C. Muckel assembled data for the Los Angeles River flood control report for the National Resources Committee. Tables were made showing the amount of water spread each month by the City of Los Angeles on the Tujunga grounds in San Fernando Valley, also the amount of water imported annually into the area by means of the Owens River Aqueduct. Tracings were made showing hydrographs of wells in the Los Angeles River basin. Annual reports of the Los Angeles department of water and supply were inspected for data which might be included in the report.

* * *

Colin A. Taylor gave an informal talk before the Lemon Men's Club, in Los Angeles, on November 2, on the subject of the broadfurrow method of irrigation. Much interest was manifested in this method. Several tests were made on the new four-furrow machine built for the City of Los Angeles for work in San Fernando Valley. Tests were also made for stabilizing a single V so that it could be pulled by one horse, this being accomplished by adding weighted wheels at the rear corners of the V. Tests have now been completed on all methods of making the broad furrows, from heavy-duty tractor outfits making four furrows in one trip per row down to single V's pulled by one animal. All of the field work has been discontinued for the present and the material developed is being prepared for inclusion in a bulletin prepared by Mr. Taylor on "A Study of Irrigation Problems in Citrus Orchards."

* * *

A report on the Bureau's cooperative fertilizer placement studies with the white pea bean in Michigan covering a period of four years was recently published in Michigan Special Bulletin 296, "Fertilizer for White Pea Beans." It was concluded that placement of 75 lb of fertilizer per acre in the furrow with the seed—a farm practice—not only failed to produce increases in yield but caused reductions in germination of the seed. The most promising placements with 300 lb of *(Continued on page 39)*

NEWS

Nominations for 1939-40 A.S.A.E. Officers

THE Nominating Committee of the American Society of Agricultural Engineers—L. F. Livingston (chairman), E. G. McKibben, and G. W. Kable—have placed in nomination the following members as candidates for the various Society offices to be filled by the annual election of officers for the Society year 1939-40:

For President

KARL J. T. EKBLAW, agricultural engineer, American Zinc Institute, and vice-president, Western Advertising Agency.

For Vice-President

J. W. CARPENTER, agricultural engineer, Caterpillar Tractor Company.

R. H. DRIFTMIER, head, agricultural engineering department, University of Georgia.

For Councilor

B. D. MOSES, associate professor of agricultural engineering, University of California.

F. E. PRICE, agricultural engineer in the experiment station, Oregon State Agricultural College.

For Nominating Committee

HOBART BERESFORD, head, department of agricultural engineering, University of Idaho.

E. C. EASTER, chief agricultural engineer, Alabama Power Company.

R. B. GRAY, chief, division of mechanical equipment, U. S. Bureau of Agricultural Engineering.

A. W. TURNER, advertising department, International Harvester Company.

I. D. WOOD, extension agricultural engineer, University of Nebraska.

The By-Laws of the Society provide that thirty days shall be allowed for additional nominations by special nominating committees, at the expiration of which period (February 20), the Secretary of the Society will mail a secret ballot to all voting members.

Fall Meeting Draws Record Attendance

FOUR hundred forty-four members and guests registered in at the fall meeting of the American Society of Agricultural Engineers, in Chicago, November 28 to December 2, setting a new attendance record. The Power and Machinery Division program drew a particularly large attendance.

Administrative and technical committee meetings and round table discussions developed into a notable feature of the gathering.

Philip S. Rose and Harry B. Walker were announced as the 1939 recipients, respectively, of the Cyrus Hall McCormick and the John Deere Medal awards at the conclusion of extended deliberations by the A.S.A.E. Jury of Awards. The announcement was made by L. J. Fletcher, retiring chairman of the Jury, at a short joint session held Wednesday afternoon, November 30. Mr. Rose was present and brought to the rostrum to receive the announcement in the presence of the assembly. Mr. Fletcher stated, in announcing Mr. Walker as the John Deere medalist, that he had been notified by telegram.

The Nominating Committee completed its slate of candidates for the next annual A.S.A.E. election, as announced elsewhere in this issue.

A Rural Electric Division roundtable on "Cooperation between Private Industry and Educational Institutions" brought to light several specific opportunities for such cooperation, some of which have been tried and proven, and others suggested.

A meeting of the Committee on Farm Fire Protection and Prevention was devoted largely to discussion of ways and means of introducing to widespread use its revised booklet on "Farm Fire Prevention and Control."

An open meeting of the Committee on Research was attended by some 30 persons who developed a lively discussion of research viewpoints, objectives, and methods.

The Committee on Specifications of Building Materials gave attention to the problem of showing farmers how various materials may be used in construction following approved basic plans.

In a meeting of the Committee on Tractor Fuels agreement was reached as to how the distillate fuel and fuel standardization problem should be presented and explained to the Society.

Progress and proposed further procedure in the cooperative research on transport wheels and tires was reported in a meeting of the committee on that subject. Agreement was reached on a means of obtaining a consensus of opinion as to the most important problems to be attacked.

Other round tables held included those of the committees on drainage, hybrid seed corn standardization, artificial drying of farm products, tractor plowing matches, farm wiring, agricultural hydrology, electric lights for insect and bacteria control, farm house standards and design, combine development, poultry housing, dairy structures and equipment, power costs for irrigation pumping, extension, and student branches.

Public recognition was accorded the meeting in an announcement of it made on "The Voice of Firestone" radio program, the evening of November 28.

November 28, the day preceding the opening of technical sessions, was reserved for administrative and technical group meetings, and somewhat relieved the pressure of activity during the remaining days.

Major program interests of the Power and Machinery Division included corn production, tractor fuels, pneumatic tires, forage crop drying, and grass silage.

Grass silage was likewise considered in the Farm Structures Division, along with the one-story dairy barn, condensation problems, grain storage, and material, design, and construction features.

Rural electric interests included the electric fence, locker storage, engineering analysis of electric uses on the farm, extension methods, use of ultra-violet light on poultry, new developments in farm use of electricity and reports on electrified farms.

The Small Water Facilities Act provided the basis for one session of the Soil and Water Conservation Division, and reservoirs and ponds another. An irrigation session was devoted to supplementary irrigation. Drainage interest felt the boost of a predicted wet phase of the weather cycle.

A moving picture of the production of steel, said to be the first industrial picture in technicolor, was an entertainment feature of exceptional engineering and extension interest, and was provided through the courtesy of the U. S. Steel Corporation.

Pacific Coast Section News

THE Executive Committee of the Pacific Coast Section of the American Society of Agricultural Engineers has decided that the customary meeting of the Section early in January will not be held this year. Instead, however, the annual business meeting and election of officers will be held at California Inn, University Campus, Davis, California, at 6 p.m., January 17, 1939. The plans now are to concentrate on a more elaborate meeting of the Section some time in the spring.

Washington News Letter

from AMERICAN ENGINEERING COUNCIL

NATIONAL PATENT INQUIRY TO BE CONDUCTED BY AMERICAN ENGINEERING COUNCIL

THE Executive Committee of American Engineering Council at its meeting on December 8 accepted the invitation of the National Industrial Conference Board to undertake a factual inquiry into the American patent system. The inquiry is to be conducted by a separate special staff employed under direction of the Patents Committee of American Engineering Council. The inquiry is to be financed from funds outside the present income of American Engineering Council, which are being provided by the National Industrial Conference Board.

The announcement of the plan was made by the National Industrial Conference Board in the following statement: "A comprehensive investigation of the whole patent problem has just been started by the National Industrial Conference Board, independent fact-finding organization of management and labor. Technical phases of the investigation will be supervised by the Committee on Patents of the American Engineering Council, while the economic aspects will be analyzed by the Conference Board's economists under supervision of Dr. Robert F. Martin, director of the Economic Research Division of the Board. Much work on the patent situation has already been done by the A.E.C. Committee under the chairmanship of R. S. McBride, consulting chemical engineer. The other members of the committee are James H. Critchett, general manager, Union Carbide & Carbon Research Laboratories, Inc., William M. Grosvener, consulting chemist *(Continued on page 39)*

Agricultural Engineering Digest

A review of current literature by R. W. TRULLINGER, assistant chief, Office of Experiment Stations, U. S. Department of Agriculture. Requests for copies of publications abstracted may be addressed to the publisher thereof or to AGRICULTURAL ENGINEERING

AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE NEBRASKA STATION, Nebraska Sta. Rpt. [1937], pp. 5-7. The progress results are briefly presented of investigations on adaptation of small electric motors to farm use, water heating for livestock, cooling milk on the farm, performance of rubber tires on tractors, mechanical equipment for the eradication of bindweed, adaptability of electric hotbeds to farm use, adaptation of insulated electric brooders in uninsulated poultry houses, and methods and equipment for curing and preserving perishable farm products under conditions of controlled temperature and humidity.

THE EFFECT OF THE DEGREE OF SLOPE AND RAINFALL CHARACTERISTICS ON RUNOFF AND SOIL EROSION, *J. H. Neal.* Missouri Sta. Res. Bul. 280 (1938), pp. 47, figs. 20. It is the purpose of this paper to present the results of a study of a few factors affecting erosion which were obtained by setting up a miniature laboratory-controlled field on which the degree and length of slope, the rainfall intensity and duration, and the soil conditions were regulated or measured. The experiment was set up to study the effect of the degree of slope and rainfall characteristics on runoff and soil erosion from a cultivated field by varying one factor at a time and keeping all others as nearly constant as possible. Rainfall intensities of 0.9, 1.5, 2, 3, and 4 in per hr were maintained within 0.2 in of the required amount. The slope was varied usually by geometric progression between 0 and 16 per cent.

A Putnam silt loam surface soil from a timothy meadow was placed in a wooden soil tank 12 ft long, 3.63 ft wide (area = 1/1000 acre), and 2 ft deep. The set-up was in a greenhouse. Artificial rain was applied by an overhead sprinkling system. The runoff and soil losses were determined at 10-min intervals under cultivated conditions for (1) slopes ranging from 0 to 16 per cent, (2) rainfall intensities ranging from 0.9 to 4 in per hr, (3) rain duration ranging up to 6 hr, and (4) different initial moisture contents and surface conditions of the soil.

The infiltration was not affected by either the slope or the rainfall intensity, but varied inversely as the initial soil moisture content. The percentage of slope had no apparent effect on the percentage of runoff for slopes above 1 per cent. The percentage of runoff increased as the rain intensity increased but at a decreasing rate.

When the soil was dry before a rain, runoff did not occur until several minutes after the rain started. The time elapsing between the beginning of the rain and the time when runoff occurred decreased as both the slope and the rainfall intensity increased. After runoff started there was a continual increase in the rate until the infiltration rate had become approximately constant. This occurred from 1 to 2 hr after the beginning of the rain. After from 1 to 2 hr the runoff was approximately constant. The density of the runoff material decreased during the first hour of a rain. When the rain continued longer, the density remained approximately constant. From 1½ to 2 times as much runoff was required to remove a pound of soil at the end of 1 hr as at the beginning of the rain. The relative density of the runoff material increased as both the slope and the rainfall intensity increased.

The soil losses from a saturated soil increased as the 0.7 power of the slope, the 2.2 power of the rainfall intensity, and directly as the time of duration of the rain. The amount of erosion from a soil which was in a dry condition at the beginning of the rain was affected by the initial soil moisture content and the condition of the soil surface, in addition to the degree of slope, the rainfall intensity, and the duration of the rain. The soil in a dry pulverized condition or one in a dry rough condition absorbed much more rainfall than when in a smooth, hard, baked condition.

A bibliography of 33 references on the subject is included.

WATER CONTROL INVESTIGATIONS, *B. S. Clayton and A. Daane.* Coop. U. S. D. A. Florida Sta. Rpt. 1937, pp. 143-145. Progress results are briefly presented.

AGRICULTURAL ENGINEERING INVESTIGATIONS BY THE MASSACHUSETTS STATION, *C. I. Gunness, H. J. Franklin, and C. R. Fellers.* Massachusetts Sta. Bul. 347 (1938), pp. 8-10. Progress results are briefly presented of investigations on cold storage of cranberries, apple storage, and low-lift pumps for cranberry bogs.

ALL-STEEL POULTRY HOUSES, *C. M. Bice and F. Botelho.* Hawaii Sta. Rpt. 1937, pp. 82, 83, fig. 1. The progress results of experiments with all-steel poultry houses for Hawaiian conditions are briefly presented.

FARM BUILDING SURVEYS IN WISCONSIN, KANSAS, GEORGIA, AND ILLINOIS, *J. R. Dodge.* (Coop. Univs. Wis., Ga., and Ill., and Kans. State Col.). U. S. Dept. Agr., Misc. Pub. 311 (1938), pp. 16. These surveys covered selected townships in Wisconsin, Kansas, Georgia, and Illinois. Their purpose was to show the actual condition of farm buildings and to determine the best approach to the problem of improving the standards of farm structures.

It was found in these areas that many structures must be repaired at once or they will soon be worthless. Many have already deteriorated to such an extent that they are beyond repair. On the majority of farms, buildings have not been properly maintained since the post-war drop in farm prices in 1920. The surveys have also showed that, despite an increase in farm income, the expenditures for improvements made in these localities during 1936 were not sufficient even to cover current depreciation, much less to repair the effects of the neglect of the past 17 yr.

The type and size of structures needed on farms has changed considerably in many sections of the country. For example, in the Kansas township surveyed, farms have increased in size since wheat has proved more dependable there than corn, alfalfa, and livestock. The type of crops grown has changed in other cases, and yields per acre of many crops have increased since the buildings were constructed. As a result there is a great need for replacement or remodeling of many of the older buildings.

CARE AND REPAIR OF COTTON-GIN BRUSHES, *V. L. Stedronsky and A. J. Johnson.* U. S. Dept. Agr. Circ. 467 (1938), pp. 14, figs. 9. Evidence is presented that worn-out or damaged gin brushes cause inefficient ginning and damage to the lint. Extensive ginning tests with brushes in good and in worn condition showed differences in ginning capacity with damp cotton of 10 per cent for staple length of 1⅛ in and longer and 7 per cent for shorter staple length. The differences between the good and worn brushes were less with dry cottons because dry fibers are easier to remove from the saws than damp fibers. Because of loss of some of the undoffed lint with the seed and inefficient ginning, lint turn-out was lower with the poor brushes than with the good brushes.

Loss in monetary value of the lint removed with poor brushes increased with moisture content of the seed cotton and with staple length, amounting to 67 cents per bale with long-staple damp cotton ginned with seed rolls of equal density. When effort was made to maintain with the poor brush a ginning capacity equal to that with the good brush, grade damage occurred in addition to losses of lint, and with the damp cottons bale-value losses amounted to $1.50 for the longer and 80 cents for the shorter staple. Practical information is given on brush repair.

SOIL EROSION SURVEY OF PENNSYLVANIA, *A. L. Patrick.* Coop. U. S. D. A., Pennsylvania Sta. Bul. 354 (1938), pp. [4] + 23, figs. 11, map 1. This bulletin discusses the kinds of erosion, results of erosion, and factors which affect the rate of erosion on some of the most important soil types of the State. A map is included which shows the prevalent types of erosion in different parts of the State.

The research program of the Soil Erosion Experiment Station located at Pennsylvania State College and conducted jointly by the college and the U.S.D.A. Soil Conservation Service is also presented.

HOME-MADE FARM EQUIPMENT, *W. P. Kintzley.* Colorado Sta. Bul. 443 (1938), pp. 20, figs. 20. This bulletin gives practical information on the construction of a motor-driven hay buck, a low platform wagon, a hayrack, fence brace, harrow platform, gate latch, and gate rest. (Continued on page 38)

Agricultural Engineering Digest

(Continued from page 36)

EROSION AND ITS CONTROL IN OKLAHOMA TERRITORY, *A. McDonald.* U. S. Dept. Agr., Misc. Pub. 301 (1938), pp. 48, figs. 11. This publication presents a historical review of erosion in Oklahoma and efforts at its control.

HANDBOOK OF ENGINEERING PRACTICES, REGION 11. U. S. Dept. Agr., Soil Conserv. Serv., [1936], pp. [9] + 99, pls. 75, figs. 34. This handbook includes chapters on field engineering, mechanical gully control, creek channel stabilization, surface runoff control, small earth fill dams, coastal sand dune control, fencing, range water supply development, field practices, drafting, miscellaneous, and tables.

DIRECTIONAL PERMEABILITY OF SEASONED WOODS TO WATER AND SOME FACTORS WHICH AFFECT IT, *H. D. Erickson, H. Schmitz, and R. A. Gortner.* Minn. Expt. Sta. Jour. Agr. Res. [U. S.], 56 (1938), No. 10, pp. 711-745, fig. 1. The directional permeabilities to water of 14 hardwoods and 2 softwoods were determined, using sections about 1.25 mm thick. In general, most of the sapwoods of species with resin canals were appreciably permeable radially at 10 cm of mercury, whereas nonresinous woods were not. The radial permeability of resinous sapwoods was much greater and more variable than that of nonresinous sapwoods. Usually, sapwood was more permeable radially than heartwood. In the sapwood, summerwood was nearly as permeable radially as springwood at 100 lb per sq in. In heartwood, springwood was usually more permeable. Tangential permeability (at high pressure) of woods with resin canals was less than radial permeability; some heartwoods were impermeable. The tangential permeability of a nonresinous wood approximated the radial value for the same wood; the sapwood was often more permeable than heartwood.

The experimental data plus the structural features of wood indicated that the observed radial flow through sapwoods with resin canals was chiefly through resin canals. In heartwood, resin canals or wood rays may have assisted flow in some woods. Wood rays probably were important paths of flow in certain woods. In general, the rate of flow decreased with increasing time of continuous flow and approached equilibrium. Several factors are given which may account for irregularities of flow. The ratio of the permeabilities (calculated to a standard basis) of some woods in the three structural directions are given. Longitudinal permeability was usually thousands of times greater than lateral permeability.

AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE IOWA STATION, *P. E. Brown, G. B. MacDonald, J. B. Davidson, H. D. Hughes, E. V. Collins, A. A. Bryan, H. R. Meldrum, C. K. Shedd, L. C. Burnett, H. Giese, and A. L. Bakke.* Iowa Sta. Rpt. 1937, pt. 2, pp. 14-17, 18, 19-21, 22, 23, figs. 2. The progress results are briefly presented of studies on soil erosion on the Marshall silt loam in Page County, of trials of the basin method of planting corn, and of studies on mechanical cultural methods and equipment for corn production, including especially equipment for seedbed preparation, planting, cultivating, and harvesting and equipment and structures for the curing and storage of corn.

MEASURING STACKS OF CHOPPED ALFALFA HAY, *R. F. Johnson.* Idaho Sta. Circ. 78 (1938), pp. 4, fig. 1. These brief investigations indicate that in stacks chopped third-cutting alfalfa is less bulky than the second cutting. A slight difference exists between third and first cuttings. The volume of chopped alfalfa hay is approximately one-third of the volume of long alfalfa hay in stacks. Under average conditions, when stacks of chopped alfalfa hay are not segregated according to cuttings, 150 cu ft per ton is a practical figure to use for computing the tonnage of stacks of chopped alfalfa hay measured according to the farmers' rule.

AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE ARIZONA STATION. Arizona Sta. Rpt. 1937, pp. 14-27, figs. 3. Progress results are briefly presented of investigations on ground water, the Eloy pumping district, corrosion of well casing, ground water law, measurement of flow of water, diesel engine-driven pumping plants, and cost and relative economy of power for deep-well pumping from diesel engines, natural gas engines, and electric motors.

AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE NEW HAMPSHIRE STATION, New Hampshire Sta. Bul. 304 (1938), pp. 32, 33. The progress results are briefly presented of investigations on electric brooding, electric fences, electric wax heating for use in the wax plucking of poultry, and pneumatic traction equipment.

AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE SOUTH DAKOTA STATION, *R. L. Patty.* South Dakota Sta. Rpt. 1937, pp. 5-7. Progress results are briefly presented of investigations on field machinery hitches for tractor and large horse teams, rammed earth for farm building walls, corn harvesting machinery, and protective coverings and life of steel fence posts.

TERRACING FOR SOIL AND WATER CONSERVATION, *C. L. Hamilton.* U. S. Dept. Agr., Farmers' Bul. 1789 (1938), pp. II + 60, figs. 37. This supersedes Bulletin 1669. It compiles the best practical information now available on terrace construction and its coordination with other recommended soil conservation practices.

CULTURAL AND STORAGE RESEARCH WITH POTATOES DURING 1936, *E. V. Hardenburg.* Amer. Potato Jour., 14 (1937), No. 7, pp. 211-215. Thirteen studies are reviewed.

THE EFFECT OF HIGH STORAGE TEMPERATURE UPON FALL-GROWN SEED IRISH POTATOES, *J. C. Miller, W. D. Kimbrough, and J. G. Richard.* Amer. Potato Jour., 14 (1937), No. 11, pp. 362-364. Yields of Louisiana fall-grown Triumph potatoes planted 30, 60, and 100 days after harvesting by the Louisiana Experiment Station varied directly with the length of time between harvesting and planting, all producing less than western dry land certified seed having a 150-day interval. Fall-grown seed kept at high temperatures (60–75 F) from harvest to planting outyielded seed kept in unheated common storage, both lots making considerably less than western dry land certified seed.

FARM STORAGE OF WHEAT AS A FACTOR IN QUALITY, *C. O. Swanson.* Northwest. Miller and Amer. Baker, 14 (1937), No. 12, pp. 35, 56. The behavior of wheat in storage is described, largely from research at the Kansas Experiment Station.

STABILIZING CORN SUPPLIES BY STORAGE, *G. Shepherd and W. W. Wilcox.* Iowa Sta. Bul. 368 (1937), pp. 293-344, figs. 20. The nature and geographical differences in the fluctuations in the size of the corn crop; the importance of corn as a feed crop; past storage by individuals; costs of storage; the effects of size of corn crop upon hog production; the relation of hog supplies, prices, and total income; effects of a corn storage program on the price of cash corn; the effects of fluctuating corn prices on hog production costs; and the fluctuations in the production of livestock other than hogs and other phases of the problem are discussed. The factors determining hog prices and corn prices, and the effects of corn loans on stability of total income are analyzed and discussed in appendixes.

The cost of storing corn was found to be 3 cents per bushel per year. With a stabilization program providing for the storage of 20 per cent of very large crops, the cost would be only 3/5 cent per bushel on the total crop. The benefits of stabilization of the supply of corn are summarized as follows:

"Livestock production, prices, and total income would be stabilized. The value of this stabilization cannot be measured in dollars and cents, but with our present highly commercialized farming and heavy fixed costs, it is without question one of the more important benefits. Total income from hog and cash corn production would be raised slightly, in the neighborhood of 1 per cent. (This increase in income alone would more than offset the costs of storage of the excess corn supplies—assuming no change in demand.) Hog production costs would be lowered by a small amount (2 to 3 per cent) through a more complete utilization of overhead costs and perhaps that much more through the adjustment of feeding operations so that a large percentage of the hogs would be marketed at optimum weights. Other livestock production costs for the same reasons would be lowered slightly. The overheard costs of transporting, processing, and distributing a more uniform supply of livestock and livestock products would be lower by several per cent. Consumers would have a more uniform supply of meat and livestock products—more when there otherwise would be a relative scarcity, less when market supplies would otherwise be burdensome. Taken all together, the benefits appear to be several times greater than the costs."

USES OF INSECT-ELECTROCUTING LIGHT TRAPS, *W. B. Herms and J. K. Ellsworth.* C. R. E. A. News Letter [Chicago], No. 15 (1937), pp. 25-29, figs. 8. This is a brief contribution from the California Experiment Station in which the progress results are briefly presented of studies on the development of insect-electrocuting light traps in California. It is pointed out that one of the principal objectives of this investigation is to develop a control of insect pests which will obviate poisonous residues. Data are given briefly on the control of the grape leafhopper, artichoke plume moth, codling moth, insects of tomatoes, mushrooms, and dried fruit, and the lima bean pod borer. *(Continued on page 40)*

Washington News Letter

(Continued from page 34)

and factory engineer, Frank B. Jewett, president, Bell Telephone Laboratories, Warner Seely, secretary, Warner and Swasey Co., and Kenneth H. Condit, executive assistant to the president, National Industrial Conference Board. Close cooperation with other organizations concerned with this problem is assured through representation on their patent committees by members of the Board's staff.

"Every phase of the patent problem will be studied by the experts of the Conference Board and Engineering Council." It is hoped the complete undertaking will be finished within twelve months and that factual sections of the inquiry can be released before that time.

DIRECTORS NAMED FOR FARM RESEARCH LABORATORIES

Directors for the four farm research laboratories to be established by the Department of Agriculture to search for new and wider industrial outlets and markets for agricultural commodities were announced on December 16, 1938 by Dr. Henry G. Knight, Chief of the Bureau of Chemistry and Soils. They are: Northern Laboratory, Peoria, Illinois; O. E. May; Southern Laboratory, New Orleans, D. F. J. Lynch; Eastern Laboratory, Philadelphia area, P. A. Wells; Western Laboratory, San Francisco area, T. L. Swenson.

Several weeks ago the Department announced the appointment of H. T. Herrick as assistant chief of the Bureau, to have general supervision of the chemical and engineering work in all four laboratories.

Each laboratory will have a broad circle of important contacts with industries, institutions, and agricultural experiment stations. These will be largely in the hands of the individual directors. Included in the laboratory staff, which will be composed of several hundred people, there will be experts in many branches of science and technology, as well as fairly large business and service departments.

ANNUAL ASSEMBLY OF A.E.C.

The Nineteenth Annual Assembly of American Engineering Council, Mayflower Hotel, Washington, D. C., January 12-14, 1939 will be conducted as a series of interprofessional discussion forums sponsored by the Public Affairs Committee of American Engineering Council, each subject under the direction of one of the several committees of Council.

EDITOR'S NOTE: Subjects to be presented by prominent speakers, and discussed by members of the interested A.E.C. committees, include "National Planning and The Engineer's Relation to It," by Dr. Harold G. Moulton, president of the Brookings Institution; "The Engineer's Relation to National Defense," by Brigadier General Earl McFarland, assistant chief of Ordinance, War Department; "The Economic Status of the Engineering and Kindred Professions," by Dr. George F. Zook, president, American Council on Education, Wm. C. Van Vleck, dean of Law School, George Washington University, and Francis P. Sullivan, chairman, committee on interprofessional relations, American Institute of Architects; "The Engineer as an Economist," by Dexter S. Kimball, past president, American Engineering Council; "Engineering Aspects of Government Reorganization," by Dr. Luther H. Gulick, Member, President's Committee on Government Reorganization; and "Engineering and Economic Factors in the Size of Business," by Dr. Willard Thorp, director of economic research, Dun and Bradstreet. A.S.A.E. members scheduled to contribute to the discussions are L. F. Livingston, R. W. Trullinger, and L. J. Fletcher.

What Agricultural Engineers Are Doing

(Continued from page 33)

fertilizer per acre were either a band 1.5 in directly under the seed or a band at a similar depth but 1.5 in to the side of the row.

* * *

S. W. McBirney reports that the Northern California Sugar Beet Conference, attended by sugar company representatives, research workers and others, took place at San Francisco on December 17. Included on the program was a report on the work of the sugar beet machinery project being carried on at Davis.

* * *

While at Urbana, Wallace Ashby visited the Soybean Investigations Laboratory where Mr. Lewis and Dr. Markley showed him soybean oil paints prepared for experimental use in protecting canvas from the weather. Arrangements have been made to use these paints on the experimental canvas-covered buildings at Beltsville, where these treatments will be compared with other types of paint.

* * *

W. V. Hukill left on December 13 for Athens, Georgia, where he will assist Messrs. Simons and Lanham in planning a publication based on the data obtained from the farmhouse comfort investigations which are being conducted there.

Preliminary reports indicate that some very interesting information has been obtained which should be of considerable value in planning and constructing farm homes in the southern states.

* * *

S. P. Lyle, formerly extension agricultural engineer of the Bureau, has been placed in charge of the new rural electrification investigations. Harry L. Garver, agricultural engineer, has recently been appointed to assist Mr. Lyle. Mr. Garver is a graduate of the State College of Washington in electrical engineering and also in hydro-electrical engineering. He also took a year of graduate work in rural electrification at the University of California. Most of the time since graduation he has been identified with the work of the Washington Committee on the Relation of Electricity to Agriculture.

Authors

Deane G. Carter is high scribe, and *David S. Weaver* high chronicler of Alpha Zeta Fraternity, which recently met at Atlantic City, N. J.

Alexander Hay has written Bulletin No. 8 of the Rubber and Agriculture Series published by the British Rubber Publicity Association, and entitled "The Uses and Possibilities of Rubber in Agriculture."

E. M. Mervine and S. W. McBirney have reported on "Developments in Mechanical Equipment and Methods in Sugar Beet Production," published as circular No. 488 of the U.S.D.A.

Claude K. Shedd and Edgar V. Collins are joint authors of "Mechanizing the Corn Harvest," U.S.D.A. Farmers' Bulletin No. 1816.

ASAE Meetings Calendar

February 1-3, 1939—Southern Section, New Orleans, La.

June 19-22, 1939—Annual meeting, University Farm, St. Paul, Minn.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the December issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Loyal A. Johnson, hydraulic engineer, Minnesota State Department of Conservation. (Mail) 3417 Portland Avenue, Minneapolis, Minn.

R. W. Louden, advertising manager, The Louden Machinery Company, Fairfield, Iowa.

Xzin McNeal, camp supervisor, State Department of Education. (Mail) Camp Couchdale, Route No. 1, Hot Springs, Ark.

Robert M. Moyer, senior engineering aide, Soil Conservation Service, U. S. Department of Agriculture. (Mail) East Main Street, Rockville, Conn.

TRANSFER OF GRADE

E. N. Humphrey, instructor, agricultural engineering department, University of Idaho, Moscow, Idaho. (Associate to Junior Member)

Student Branch News

IDAHO

At the first regular bi-monthly meeting of the Idaho Student Branch of the American Society of Agricultural Engineers held September 26, 1938, the following officers were elected for the year: Robert Linkhart, president; Max Jensen, vice-president; and Owen Brown, secretary and treasurer. At this meeting a silver plaque was presented by the Branch to William Watson, with his name inscribed upon it for having been chosen the outstanding agricultural engineering student at the University of Idaho for the 1937-38 school year. The selection of the winner is based on attitude, scholarship, activity, and effort. Presentation of the plaque to the agricultural engineering student best filling these requirements will be an annual event.

A later meeting featured an evening picnic which is an annual function, to receive new members and to get better acquainted.

At the October 20 meeting, moving pictures were shown by Professor Beresford on "Modern Farm Methods in Idaho." The pictures were filmed by him, J. B. Rodgers, and Ben Humphrey.

On November 2, the Branch was the guest of the Washington State College Branch at a joint meeting held in Pullman, Washington. The speaker for the evening was Senator Clemgard, state senator and well-known rancher of Pullman. During the evening, several interesting motion pictures depicting power-farming operations on his modern farm near Pullman were shown by Senator Clemgard. The films were of further interest to the group as they were of the 16 mm color-sound type.

Further plans for the year include joint meetings with other engineering groups, outside speakers, student branch publication, and trips.

Agricultural Engineering Digest

(Continued from page 38)

COLD STORAGE STUDIES OF FLORIDA CITRUS FRUITS.—III. THE RELATION OF STORAGE ATMOSPHERE TO THE KEEPING QUALITY OF CITRUS FRUIT IN COLD STORAGE, *A. L. Stahl and J. C. Cain.* Florida Sta. Bul. 316 (1937), pp. 44, figs. 12. In this third paper, the author discusses the effects of various gaseous atmospheres and humidity conditions on citrus fruit in cold storage. A high relative humidity was found essential in preventing loss of weight, retaining firmness, and preventing pitting. Both taste and texture of grapefruit were affected by the nature of the atmosphere, both O_2 and CO_2 proving harmful in high concentrations. Fruit stored in N_2 developed a musty, disagreeable taste, but retained firmness and bright color. Pitting was apparently increased by O_2 and slightly reduced by N_2 or by small amounts of CO_2. Sogginess, a condition first evident by soft, dull-colored areas at the blossom end and gradually extending through the entire fruit, was definitely induced by CO_2. Once initiated, sogginess was not overcome by treatments with O_2. Forced air circulation was found harmful with respect to the duration of keeping and the maintenance of weight. Still-air storage low in CO_2 and O_2 and high in relative humidity made possible good keeping for 4 mo. Covering stacked boxes with a tarpaulin produced a favorable environment on a small scale. The application of the findings to commercial storage practices is discussed. Appended is a preliminary report by Cain for a method for measuring CO_2 respired by citrus fruits.

THE PAINTING OF SAP BUCKETS AND OTHER EQUIPMENT USED IN THE PRODUCTION OF MAPLE SYRUP, *C. O. Willits.* New York State Sta. Circ. 182 (1938), pp. 4. Practical information is given on the subject.

Literature Received

"BEHOLD OUR LAND," by Russell Lord. The American soil conservation situation dramatized in figurative technicolor to the taste of the Scientific Book Club and popular readers. Soil is presented historically, geographically, and in relation to people and land use, as well as in physical terms. The author concludes that soil conservation work will grow, and that it offers to young people a field of service worthy of serious consideration as a life work. Houghton Mifflin Co. $3.00.

EMPLOYMENT BULLETIN

The American Society of Agricultural Engineers conducts an employment service especially for the benefit of its members. Only Society members in good standing may insert notices under "Positions Wanted," or apply for positions under "Positions Open." Both non-members and members seeking to fill positions, for which ASAE members are qualified, are privileged to insert notices under "Positions Open," and to be referred to members listed under "Positions Wanted." Any notice in this bulletin will be inserted once and will thereafter be discontinued, unless additional insertions are requested. There is no charge for notices published in this bulletin. Requests for insertions should be addressed to ASAE, St. Joseph, Michigan.

POSITIONS OPEN

ENGINEER wanted by a farm machine manufacturer. Must be a man in his thirties who has a bachelor of science degree in mechanical engineering or agricultural engineering and whose field is machine design of farm equipment. Being a machine designer he should be thoroughly familiar with most of the manufacturing processes including founding, machining, welding, grinding, etc. Beginning salary, $2500; top salary, $5200.—PO-122

POSITIONS WANTED

AGRICULTURAL ENGINEER, for two years charged with the administration and coordination of complete erosion control program for U. S. Soil Conservation Service CCC project in Louisiana. Prior to this, prepared plans, specifications, and cost estimates of Castor Creek watershed gully control project, and supervised project when approved. Served several months with L.S.U. Extension Service. For nine years after completing college was engaged in supervisory capacity constructing large bridges and locks. Prefers connection in university or industrial extension, with equipment manufacturer, or in experimental work. Can furnish best of references. Will go anywhere. Married, two children. Age 35. PW-298

AGRICULTURAL AND CHEMICAL ENGINEER with master's degree in agricultural engineering. Eight years' experience in agricultural engineering teaching and research. Three years' experience in chemical industry. Desires position in teaching or research. Age 35. Married. PW-299